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CORRECTION

MONTHLY WEATHER REVIEW, February, 1926, 54:

Page 61, first column, table of sunspots, the mean for the February column recorded "201.8" should be "21.8."

MONTHLY WEATHER REVIEW, May, 1926, 54:

Page 220, Table 1, first column, the figures for Dutch Harbor should be respectively: 29.54, −0.29, 30.26, 2d, 28.92, 17th.

† In marine separate.

MONTHLY WEATHER REVIEW

Editor, ALFRED J. HENRY   Assistant Editor, BURTON M. VARNEY

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A NEW PROOF OF THE VARIABILITY OF THE SUN, BASED ON MOUNT WILSON OBSERVATIONS

By C. G. ABBOT, Assistant Secretary

[Smithsonian Institution, Washington, June 21, 1926]

On returning from abroad, I find that a number of critical articles have appeared which seem to indicate great doubt, not only as to the existence of short-interval variations of the sun's radiation, but even of the longer-interval swings which seem to be exposed by the work of the Smithsonian Astrophysical Observatory. It is said that traces of yearly periodicity are found which lead to the hypothesis that the variations are due to terrestrial influences. It is said that the pyrheliometer observes so much sky around the sun that variations of the haziness of the sky introduce variations of solar constant determinations by no means negligible. It is said that the work at Mount Wilson, which continued over the summer and autumn months of many years, is so inaccurate, owing to terrestrial influences, that it may be discarded from consideration, and with it all applications which have been made of those results to weather conditions.[1] It is said that the computations and assumptions made in connection with the bolometric observations are so complex and doubtful that the variations which are found in the solar constant are more probably due to these than to real variations in the sun.

It would be easy to collect very extensive matter in rebuttal, after which the authors of the criticisms would doubtless again bring in a rejoinder, and so the controversy might go on indefinitely without convincing the authors on either side and leading the readers into a hopeless state of uncertainty. Fortunately, a very simple consideration has occurred to me which, it seems probable, may convince the critics of the variation of the sun that both long and short period fluctuations really exist, and that the work of Mount Wilson should not be rejected.

The new consideration may be understood by reflecting that if the observer could locate himself upon the moon he would need there only the pyrheliometer to follow the variations of the sun,[2] because there would be no screen interposing between him and its rays, and if instrumentally accurate his results would be real indications of the constancy or variability of the sun itself. In the actual conditions the observer is hindered by the presence of the ocean of atmosphere above him, which contains variable elements. If it were possible to confine observing to conditions in which these variable elements remained sensibly constant, the presence of the atmosphere would no longer be a hindrance to determining the variability of the sun. It would then become like a partially transparent screen, reducing, it is true, the solar rays, but reducing them in the same proportion on every day of observation. Let us consider whether this device can not be employed.

Between the years 1910 and 1920 the intensity of solar radiation was observed on many days of the summer and autumn months by means of two pyrheliometers mounted upon a single stand and read alternately, and usually by one or the other of two observers, C. G. Abbot and L. B. Aldrich. On numerous occasions during this interval these pyrheliometers were compared with the standard water-flow pryheliometer, and with various secondary pyrheliometers, which were also intercompared between themselves. As indicated in Volume IV of the Annals of the Astrophysical Observatory, this series of intercomparisons of pyrheliometers does not indicate fluctuations of consequence in the scale of readings of these instruments. During all this interval, bolometric observations were made on the same days with the pyrheliometric work, and there were determined from these spectrobolometric curves, by the method of Fowle, the total quantity of precipitable water between the observer and the limit of the atmosphere. This method, as is stated in Volume IV of the Annals of the Astrophysical Observatory, has been checked by Mr. Aldrich and Mr. Fowle with favorable results. In the use which I shall make of it here it is not, however, necessary to suppose that the actual quantities of precipitable water determined are strictly correct, because the application is limited to the determination of days of equal quantities of precipitable water. This merely means that the depth of certain great water vapor bands in the bolographs of the infra-red spectrum were substantially identical for equal air masses, and this is surely an indication that the total quantity of water in the atmosphere was for these days substantially equal.

Taking, then, this homogeneous body of pyrheliometric observations, I have limited myself in the present article mainly to the month of July. In this month the distance of the sun is so nearly uniform that it is not necessary for the present purpose to make corrections for solar distance. Any question of the yearly periodicity in the solar constant values is obviously eliminated.

The first question, then, is: Does the pyrheliometric work of Julys from 1910 to 1920 indicate that on some of these Julys the sun's radiation was more intense than on others?

To solve this question, I divided the observations as reported in Volume IV of the Annals of the Astrophysical Observatory into four groups. Group 1 contained only

[1] The reader may here profitably refer to the MONTHLY WEATHER REVIEW for July, 1925, p. 286, quotation in second column, not omitting the seventh sentence.

[2] See MONTHLY WEATHER REVIEW, July, 1925, p. 290, the first two paragraphs under "Analysis of Pyrheliometer Readings" * * *, etc.

See also MONTHLY WEATHER REVIEW. December, 1925, p. 527, first paragraph of second column.

those days in which the apparent atmospheric transparency, as determined by the pyrheliometer alone, lay between narrow limits, whose mean was approximately 0.904, and when the precipitable water lay between narrow limits averaging approximately 5 mm. Group 2 contained only days in which the atmospheric transparency, still within narrow limits, was somewhat less and the precipitable water, also within narrow limits, was approximately 12 mm. Group 3 contained only those days in which the atmospheric transparency, still between narrow limits, was again less, and the precipitable water, also between narrow limits, was approximately 20 mm. Group 4 contained the days which were rejected, either because the precipitable water much exceeded 20 mm., or the transparency, if falling within one of the groups, was accompanied by precipitable water conditions which did not fall in the same group. There remained, after this rejection, numbers of days which are given in Table 2, which follows.

To illustrate the grouping, I give in Table 1 the arrangement of data for the month of July, 1915. Values have been printed in three types for a purpose which will appear later.

TABLE 1.—*Sample grouping*

Date	Ppt. H_2O	App. "a"	Pyrh.[1] m=1.5	Solar constant E'_0
	Mm.			
5	*4.9*	*0.896*	*2.855*	*1.930*
16	**5.5**	**.901**	**2.935**	**1.976**
17	**3.6**	**.906**	**2.940**	**1.979**
26	*7.9*	*.904*	*2.842*	*1.950*
27	**4.1**	**.906**	**2.923**	**1.943**
28	**3.5**	**.908**	**2.930**	**1.936**
29	*7.0*	*.900*	*2.840*	*1.934*
31	*6.9*	*.907*	*2.805*	*1.906*
Mean	5.4	.903	2.884	1.944
10	*14.8*	*.895*	*2.737*	*1.929*
11	11.7	.897	2.800	1.947
12	12.4	.891	2.790	1.947
13	*11.4*	*.881*	*2.765*	*1.959*
14	**8.6**	**.895**	**2.860**	**1.949**
18	**10.2**	**.909**	**2.857**	**1.960**
Mean	11.5	.895	2.802	1.948
3	*18.3*	*.894*	*2.690*	*1.915*
7	21.9	.884	2.710	1.968
8	21.2	.888	2.710	1.955
9	**15.6**	**.887**	**2.764**	**1.934**
Mean	19.2	.888	2.719	1.943

[1] To reduce to calories, multiply by 0.511.

TABLE 2.—*Summary of observations*

Year	Group	Number of days	July dates	Group weights	Ppt. H_2O Mean	Ppt. H_2O Range	Apparent "a" Mean	Apparent "a" Range	Pyrheliometer at air mass 1.5 Value	Pyrheliometer at air mass 1.5 Range	Solar constant E'_0 Mean	Solar constant E'_0 Range	Ratio to general mean of group Pyr.	Ratio to general mean of group S. C.
					Mm.	*Mm.*							*1±%*	*1±%*
1910	1	6	2, 3, 4, 5, 8, 28	24	4.9	4.2	0.902	0.011	1 461	0.110	1.899	0.070	−1.02	−2.01
	2	3	6, 7, 15	9	11.7	6.6	.897	.000	1.395	0.113	1.909	0.071	−1.06	−1.34
	3	1	19	2	22.0		.879		1.360		1.963		−0.08	+0.41
			Total	35							Weighted mean		−0.95	−1.70
1911	1	6	1, 4, 5, 24, 30, 31	24	4.8	3.4	.904	.011	1.468	0.082	1.927	0.085	−0.54	−0.57
	2	2	7, 12	6	9.7	1.2	.901	.009	1.388	0.009	1.895	0.088	−1.56	−2.06
	3	2	13, 20	4	22.0	1.9	.885	.016	1.333	0.024	1.888	0.086	−2.06	−3.44
			Total	34							Weighted mean		−0.60	−1.17
1914	1	3	27, 28, 29	12	6.8	3.8	.903	.002	1.462	0.041	1.947	0.047	−0.95	+0.46
	2	4	1, 2, 17, 26	12	13.2	7.6	.892	.008	1.398	0.046	1.949	0.039	−0.85	+0.72
	3	5	18, 19, 20, 21, 30	10	18.6	3.2	.878	.018	1.357	0.006	1.967	0.127	−0.30	+0.62
			Total	34							Weighted mean		−0.72	+0.60
1915	1	8	5, 16, 17, 26, 27, 28, 29, 31	32	5.4	4.4	.903	.012	1.474	0.069	1.944	0.073	−0.14	+0.31
	2	6	10, 11, 12, 13, 14, 18	18	11.5	6.2	.895	.028	1.432	0.063	1.948	0.031	+1.56	+0.67
	3	4	3, 7, 8, 9	8	19.2	6.3	.888	.010	1.389	0.057	1.943	0.053	+2.06	−0.62
			Total	58							Weighted mean		+0.69	+0.30
1916	1	8	3, 4, 5, 6, 17, 18, 25, 28	32	5.8	3.2	.905	.009	1.480	0.040	1.945	0.022	+0.27	+0.36
	2	4	1, 10, 12, 15	12	11.6	4.8	.896	.015	1.399	0.064	1.908	0.048	−0.80	−1.39
	3	2	11, 31	4	17.0	0.7	.887	.020	1.367	0.025	1.929	0.027	+0.44	−1.33
			Total	48							Weighted mean		+0.02	−0.22
1917	1	2	8, 9	8	4.2	0.8	.896	.006	1.475	0.038	1.929	0.017	−0.07	−0.47
	2	0												
	3	4	5, 6, 7, 19	8	16.8	6.0	.878	.017	1.396	0.028	2.007	0.088	+2.58	+2.67
			Total	16							Weighted mean		+1.26	+1.11
1918	1	6	11, 24, 25, 26, 27, 28	24	3.4	3.0	.902	.023	1.492	0.006	1.960	0.104	+1.10	+1.14
	2	6	6, 14, 15, 21, 22, 23	18	12.3	4.5	.895	.016	1.413	0.027	1.943	0.051	+0.21	+0.41
	3	4	4, 5, 9, 29	8	20.1	3.6	.877	.026	1.352	0.071	1.950	0.114	−0.66	+0.20
			Total	50							Weighted mean		+0.44	+0.73
1919	1	4	1, 20, 30, 31	16	5.0	4.9	.901	.015	1.493	0.060	1.955	0.060	+1.15	+0.88
	2	4	2, 3, 6, 7	12	11.9	3.3	.885	.019	1.414	0.013	1.944	0.057	+0.28	+0.47
	3	3	10, 11, 14	6	23.8	4.6	.876	.032	1.322	0.078	1.952	0.019	−2.87	−0.15
			Total	34							Weighted mean		+0.13	+0.55
1920	1	5	9, 11, 12, 13, 19	20	6.3	4.2	.903	.019	1.475	0.027	1.942	0.022	−0.07	+0.21
	2	7	8, 10, 14, 17, 18, 25, 26	21	13.6	5.0	.885	.015	1.414	0.023	1.934	0.060	+0.28	−0.06
	3	2	24, 29	4	21.0	2.1	.881	.006	1.338	0.064	1.934	0.008	−1.70	−1.28
			Total	45							Weighted mean		−0.52	−0.49

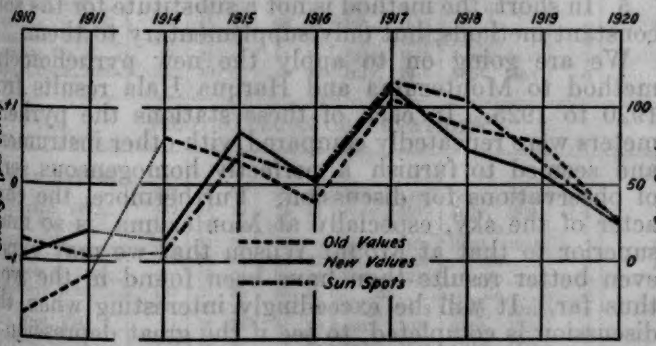
On each of the days included in groups 1, 2, and 3 the reading of the pyrheliometer as it would have been found at air mass 1.5 was determined by logarithmic interpolation from the series of observations reported in Volume IV of the Annals, and on each of the days the value of the solar constant of radiation, E'_0, as given in

Volume IV of the Annals, was taken out. Mean values for the pyrheliometry at air mass 1.5 and for the solar constant were obtained for each group in each month.

It was necessary to omit the years 1912 and 1913 in this analysis, because the volcanic dust thrown up in the great eruption of Mount Katmai had rendered the atmosphere so turbid that, although precipitable water conditions suitable to the groups were available, they were not accompanied by transmission coefficients which fitted at all. Accordingly, these years were rejected from the study.

Readers will perceive that errors due to extraneous radiation from the sky and toward the sky around the sun seen by the pyrheliometer are minimized in this method of treatment because the brightness and transparency of the atmosphere were practically identical for all days and years within the same group, and because since all observations are taken in July the outgoing radiation from the instrument reached atmospheric regions of nearly the same temperature from year to year. Also errors from changing transparency during a day are minimized because, first, no exceptional days were included, and, second, because all observations relate to one and the same moment of the day and not, as in the long method bolometry, to a period of several hours.

It was considered that the individual days of the several groups should receive different weights, and after consideration, the convention was adopted that individual days falling in group 1 should receive weight 4; those in group 2, weight 3; and those in group 3, weight 2, respectively. With this convention, and in consideration of the numbers of days in the several groups, there were obtained for the whole interval 1910 to 1920,[3] group means both of the pyrheliometry at air mass 1.5 and of the solar constant E'_0. See Table 4 below. From these group means were taken the percentage departures of the group means for the several Julys, as indicated in Table 2. Finally, in order to get single values representing the pyrheliometric and bolometric result of each July, the weighted mean of the percentage departures for the three groups was determined, as noted in Table 2, and which are summarized as the results of the investigation in Table 3. The results are also shown graphically in the accompanying illustration.



It will be perceived that with the exception of July, 1914, there is a very close agreement between the bolometric and pyrheliometric results, and that both are in strong correlation with the variation of the sun-spot numbers. I have also tried the month of August for the same interval, in the same manner, and have obtained results of the same general import, though they also indicate a departure in the same sense for the bolometric result of 1914.[4] Thus, this new and simple method confirms the result formerly obtained from Mount Wilson solar constant determinations to the effect that in a term of years the intensity of solar radiation increases with sun-spot numbers. The new work supports the solar constant values both as to the times and magnitudes of the change.

TABLE 3.—*Long-interval solar variations, July*

(Mount Wilson Data)

Year	Percentage departures		Sun-spot numbers
	Pyrh. M=1.5	Solar constant E'_0	
1910	−0.95	−1.70	14
1911	−0.60	−1.17	3
1914	−0.72	+0.60	5
1915	+0.69	+0.30	71
1916	+0.02	−0.22	53
1917	+1.26	+1.11	117
1918	+0.44	+0.73	105
1919	+0.13	+0.55	64
1920	−0.52	−0.49	26

In the following Table 4, are given the group means for the solar constant (E'_0) and pyrheliometry (M = 1.5) for the whole series of Julys and Augusts. In obtaining all the pyrheliometric values for August, I allowed for the variation in solar distance and computed the values for the same solar distance as of July 15, in order to fit them for use in Table 5, below.

TABLE 4.—*Group mean solar constant and pyrheliometric values*

Group	Solar constant E'_0			Pyrheliometry M=1.5		
	1	2	3	1	2	3
Mean values:						
July	1.938	1.935	1.955	1.476	1.410	1.361
August	1.937	1.942	1.957	1.471	1.391	1.318

It will be noted that the agreement of solar constant values for Groups 1 and 2 for July and August is as close as could be hoped for, but that in each case the mean for Group 3 is about 1 per cent higher than for the others. This, I am inclined to think, is a real indication that the solar constant values obtained on Mount Wilson on days of excessive haziness and humidity were made too high by reason of the influence of sky radiation. Doctor Dorno points out this source of error in the MONTHLY WEATHER REVIEW for December. We had become aware of it a good while before, and had taken measures to evaluate its magnitude and to eliminate it in future work. I hope to treat this matter more extensively in a forthcoming publication.

It is to be noted that in taking the mean monthly departures of the solar constant in Table 3 of this present communication, they are not comparable with the departures which could be taken for the mean monthly values published by Mr. Clayton in Smithsonian Miscellaneous Collections, vol. 77, No. 6, and in Table 53 of Volume IV of the Annals of the Astrophysical Observatory, for two reasons.

[3] The Mount Wilson solar constant values for 1919 and 1920 are taken here as they were in Tables 49 and 50 of Volume IV of the Annals of the Astrophysical Observatory of the Smithsonian Institution, for reasons stated on page 177 thereof.

[4] One is inclined to think from the results of both July and August that for some reasons the bolometric results of 1914 are about 1 per cent high throughout that year, a conclusion which is quite in line with their departure from what would be expected at that time of the sun-spot cycle. I have made a partial investigation of this question and find that the atmospheric transmission coefficients for the different wave lengths for 1914 were lower than would be expected for days of equal precipitable water for other years, and it is possible that we may be able to find why the results of this year are thus out of line

In the first place, present departures are given in percentages calculated severally from the general means of the three groups above described. Thereby the correction for sky brightness which I have just explained is eliminated.

In the second place, the mean monthly values given by Mr. Clayton and published in Volume IV of the Annals include all of the days, among them those of Group 4 which have been rejected in this discussion, for the reasons given above.

As stated by me in Smithsonian Miscellaneous Collections, vol. 77, No. 5, p. 3, I had supposed that the range of solar constant values given in the Annals for Mount Wilson was perhaps twice as great as the true one on account of the sources of error which I discussed there. This expectation is now confirmed, for it is seen that the range of results for the month of July given in Table 53 of Volume IV of the Annals is about double the range which is given in Figure 1 of the present paper.

TABLE 5.—*Proof of short-interval solar variation*

(Percentage deviations from monthly means for individual days)

Month	High values			Medium values			Low values		
	Number of days	Pyrh. mean	Solar constant mean	Number of days	Pyrh. mean	Solar constant mean	Number of days	Pyrh. mean	Solar constant mean
1910, July	2	2.56	1.68	2	−0.09	−0.47	2	−2.45	−1.05
1911	2	2.32	1.63	2	+0.18	−0.92	2	−2.40	−1.74
1914	1	1.38	0.10	1	0.00	−1.32	1	−1.41	+0.10
1915	4	1.69	0.52	------	------	------	4	−1.67	−0.84
1916	3	0.82	−0.09	2	+0.33	−0.11	3	−1.07	+0.14
1917	1	1.31	0.48	------	------	------	1	−1.31	−0.42
1918	3	1.28	0.82	------	------	------	3	−1.29	−0.86
1919	3	0.87	−0.10	------	------	------	1	−2.65	+0.32
1920	2	0.50	0.16	2	−0.02	+0.10	1	−1.10	−0.41
1910, August	5	2.11	0.51	------	------	------	4	−2.67	−0.62
1911	6	1.71	0.91	3	+0.02	−0.24	10	−1.02	−0.46
1914	2	1.10	0.15	2	+0.11	−0.93	1	−2.42	+1.50
1915	6	0.87	0.16	3	−0.21	+0.33	5	−1.12	−0.45
1916	2	2.84	0.54	------	------	------	5	−1.16	−0.29
1917	3	0.97	0.69	1	+0.20	−0.36	2	−1.55	−0.13
1918	1	2.48	1.04	2	−0.09	−0.38	2	−1.29	−0.19
1919	3	0.73	0.02	------	------	------	1	−1.37	−0.10
1920	2	1.00	0.46	------	------	------	3	−0.67	−0.61
Total	51			20			51		
Weighted mean	------	+1.43	+0.51		+0.03	−0.34		−1.47	−0.42

I have used this new pyrheliometric method of consideration not only as furnishing evidence of long interval fluctuations of the solar radiation, but to determine whether short interval solar changes are also probably real. For this purpose I have confined myself to the values in Group 1 as having greater weight than the others. These values I have divided, in each month (July and August, 1910 to 1920) as between high, medium, and low. Medium values, however, are frequently absent. All of the days included in Table 1 are thus indicated by distinctive types, but though doubtless Groups 2 and 3 would show the phenomenon, I have, as stated above, employed only Group 1 in this study. I have set over against the pyrheliometry the solar constant values, E'_0, found on the same identical days. Obviously the range of pyrheliometry includes its errors and differences of conditions. Hence it must exceed the range of solar constant values for identical days whose errors may tend in opposite directions. In each instance I have determined the percentage departure from the mean of that group for that individual month, both of the pyrheliometry at air mass 1.5 and of the solar constant value E6. In general, the two sets of data agree as showing which are the days of high and days of low solar constant. The monthly values and the mean of all the results are as given in Table 5.

From this, it seems to be indicated that not only did the solar constant vary in a close relation with the sunspot numbers during the months of July and August from 1910 to 1920 (excluding the years 1912 and 1913, which were not capable of treatment by the new method) but also that during this long period of time the high and low days for the months of July and August indicated themselves in the pyrheliometry quite as plainly as in the solar constant values published in Volume IV of the Annals, and on the whole in harmony therewith.

The pyrheliometric method which I have explained has some valuable applications and certain limitations, as shown in Table 5.

Advantages of the method.—1. It is direct, for it simply employs measurements of total radiation, without spectrum work except as an indication of atmospheric humidity.

2. It is competent to confirm the existence of solar variability both of long and short interval.

3. It furnishes means of testing whether the general scale of solar constant determinations remains unchanged over a period of years.

4. It will give new testimony as to the reality of certain apparent prolonged depressions of the solar constant, which, if real, are important.

Disadvantages of the method.—1. The pyrheliometric method can not be applied convincingly to treat long interval variations in years like 1912 and 1913 when the atmospheric transparency for equal humidity was abnormally low on account of volcanic dust.

2. It is unsatisfactory except for stations of very excellent and uniform conditions.

3. It is applicable to only a part of the cloudless days at any station, because on some days the relations between atmospheric humidity and transparency are so abnormal that such days fit none of the groups.

4. It is incapable of giving individual results. Differences between sky conditions of different days, even if small, produce differences of pyrheliometeric readings. These must be eliminated by taking means for many days.

5. In short, the method is not a substitute for the solar constant methods, but only supplementary to them.

We are going on to apply the new pyrheliometric method to Montezuma and Harqua Hala results from 1920 to 1925. In each of these stations the pyrheliometers were repeatedly compared with other instruments and seemed to furnish a perfectly homogeneous series of observations for discussion. Furthermore, the character of the sky, especially at Montezuma, is so much superior to that at Mount Wilson that we may expect even better results than have been found in the work thus far. It will be exceedingly interesting when this discussion is completed, to see if the great depression of the solar constant from about March, 1922, to the present time is verified, and it will be exceedingly valuable to assure ourselves that the scale of observations throughout the recent period has remained unchanged.

I hope soon to publish the results of such a study in the Smithsonian Miscellaneous Collections, and at that time to discuss more fully the influence of radiation from and toward the sky near the sun, and the influence of volcanic dust in solar constant values.

A SUMMARY OF AEROLOGICAL OBSERVATIONS MADE IN WELL-PRONOUNCED HIGHS AND LOWS

By L. T. SAMUELS

[U. S. Weather Bureau, Washington, D. C., April, 1926]

SYNOPSIS

The primary purpose in preparing this paper has been to determine the oustanding characteristics of *well-pronounced* HIGHS and LOWS as well as such features as distinguish them from each other. The mean free-air winds, temperatures, relative humidities and vapor pressures were determined for summer and winter at a number of stations in the United States for the four quadrants and the center of each pressure system. An accurate comparison of the two methods of observation, viz, kite and pilot balloon, was made possible by summarizing these data separately.

INTRODUCTION

It is recognized that mean values tend to conceal important characteristics peculiar to individual HIGHS and LOWS, which must in themselves be analyzed in any study of the fundamental mechanics involved. However, averages based on the more typical cases have their uses and are necessary in determining basic values, so that departures therefrom may not only be more readily identified but their significance better realized as well. The relative importance of the various physical processes involved in producing the mean values is seldom if ever the same in the individual cases and therefore the discussion of these means will be limited mostly to statements of facts supplementary to the illustrations and tables.

This paper on the free-air conditions associated with certain types of pressure distribution as depicted on the daily weather maps is based on observations made at approximately the time represented on the maps, viz, 8 a. m., 75th meridian time. The stations and periods of record used are shown in Table 1.

TABLE 1

KITE OBSERVATIONS

Station	Altitude (m.), m. s. l.	Latitude (N.)	Longitude (W.)	Period of record (inclusive) From—	To—	Years	Months
		° ′	° ′				
Broken Arrow, Okla.	233	36 02	95 49	Aug., 1918	Sept., 1924	6	2
Drexel, Nebr.	396	41 20	96 16	Nov., 1915	do	8	11
Due West, S. C.	217	34 21	82 22	Mar., 1921	do	3	7
Ellendale, N. Dak.	444	45 59	98 34	Jan., 1918	do	6	10
Groesbeck, Tex.	141	31 30	96 28	Oct., 1918	do	6	0
Leesburg, Ga.	85	31 47	84 14	Mar., 1919	June, 1920	1	4
Royal Center, Ind.	225	40 53	86 29	July, 1918	Sept., 1924	6	3

PILOT-BALLOON OBSERVATIONS

Station	Altitude (m.), m. s. l.	Latitude (N.)	Longitude (W.)	From—	To—	Years	Months
Broken Arrow, Okla.	235	36 02	95 49	Oct., 1918	Sept., 1924	6	0
Burlington, Vt.	132	44 29	73 13	Nov., 1919	July, 1921	1	9
Denver, Colo.	1,620	39 48	105 00	do	do	1	9
Drexel, Nebr.	396	41 20	96 16	Nov., 1921	Sept., 1924	2	11
Due West, S. C.	217	34 21	82 22	Dec., 1920	do	3	10
Ellendale, N. Dak.	442	45 59	98 34	Oct., 1918	do	6	0
Groesbeck, Tex.	139	31 30	96 28	do	do	6	0
Ithaca, N. Y.	291	42 26	76 34	July, 1919	July, 1921	2	1
Key West, Fla.	11	24 33	81 48	July, 1920	Sept., 1924	4	3
Lansing, Mich.	263	42 45	84 38	June, 1919	July, 1921	2	2
Leesburg, Ga.	84	31 47	84 14	Oct., 1918	Sept., 1920	2	0
Madison, Wis.	307	43 03	89 18	May, 1919	July, 1921	2	3
Royal Center, Ind.	228	40 53	86 29	Oct., 1918	Sept., 1924	6	0
Washington, D. C.	34	38 53	77 31	Dec., 1918	do	5	10

Kite and pilot-balloon observations have been classified separately according to the position of the station with reference to the center of well-pronounced HIGHS and LOWS, as shown on the morning weather maps. By well pronounced HIGHS and LOWS is meant those pressure areas having in general a concentric system of three or more isobars and a gradient of at least 0.1 inch per 200 miles in the region where the isobars are nearest together. It is believed that a smaller number of observations made under *well-pronounced* pressure conditions are, for purposes of determining outstanding and distinctive characteristics of HIGHS and LOWS, superior to a greater number that would necessarily include many cases with poorly defined pressure distribution. Hence only such pressure areas were considered as unquestionably had a controlling influence over the station, i. e., the latter was situated *within* the concentric system of isobars about the center. Hereafter all references to HIGHS and LOWS are to the *well-pronounced* types only.

Those pressure areas selected were divided into quadrants and the center, designated as follows: I–NE, II–NW, III–SW, IV–SE and center. (See fig. 17.) By such a division, the first and fourth quadrants imply, in general, the front sector and the second and third quadrants the rear sector of the pressure area. This, of course, is true only when the direction of movement of the pressure area is toward the east, but since a westerly direction in these regions is so rare this nomenclature, it is believed, will not lead to confusion in the consideration of the mean values shown here.

Pilot-balloon observations have been referred to ground level and kite observations to sea level. In the latter the ascents only were used, in order to secure a record of conditions as nearly simultaneous as possible. The average time required for the kite to reach its maximum altitude was about two hours and since the ordinary diurnal variation during this interval is most pronounced at the surface and diminishes with altitude to about 500 m., above which it is usually very small, the observations may be regarded as practically simultaneous for free-air levels.

It is evident that the location of a station, with respect to the most frequented tracks of HIGHS and LOWS, determines to a large extent the quadrants best represented in a classification of this kind. Another factor, however, is the weather conditions associated with certain quadrants, some being more favorable than others for making aerological observations. In order, therefore, that a general perspective of the net results in this regard may be obtained, Figures 1 to 8 have been prepared.

In no case has any quadrant been considered sufficiently represented to be included in the charts unless five or more observations were obtained within it. Owing to the limited number of observations, only two seasons were used, viz, summer (June, July, August, and September) and winter (December, January, February, and March).

It may be questioned whether mean values based on so small a number of observations as were here used, especially for some quadrants, are properly representative. Although a longer series would very likely alter these means to some extent, yet in their present form they are certainly significant for comparison since they represent the more pronounced pressure types. Furthermore, the relatively large number of stations making aerological observations affords opportunity to compare the results for corresponding quadrants, thereby providing a check against any appreciable error which might occur if the records from *one* station only were being used. On the whole, it is believed that these averages may be safely accepted qualitatively and, except in those cases where the number of observations is comparatively small, in a fairly reliable quantitative degree as well.

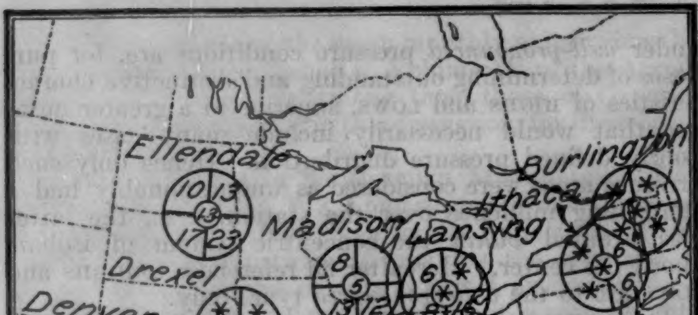


FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIGS. 1-8.—Number of observations in various quadrants and the center of well-pronounced HIGHS and LOWS in summer and winter, on which are based the mean values shown in subsequent graphs and tables. (A * indicates less than five observations; their means, therefore, are not included.) (For Figs. 5-8, see opposite page.)

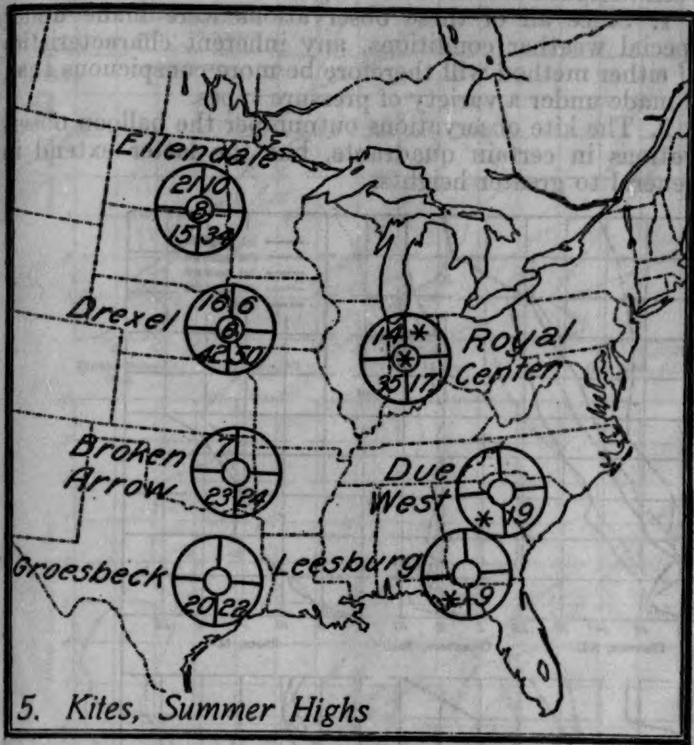


FIG. 5

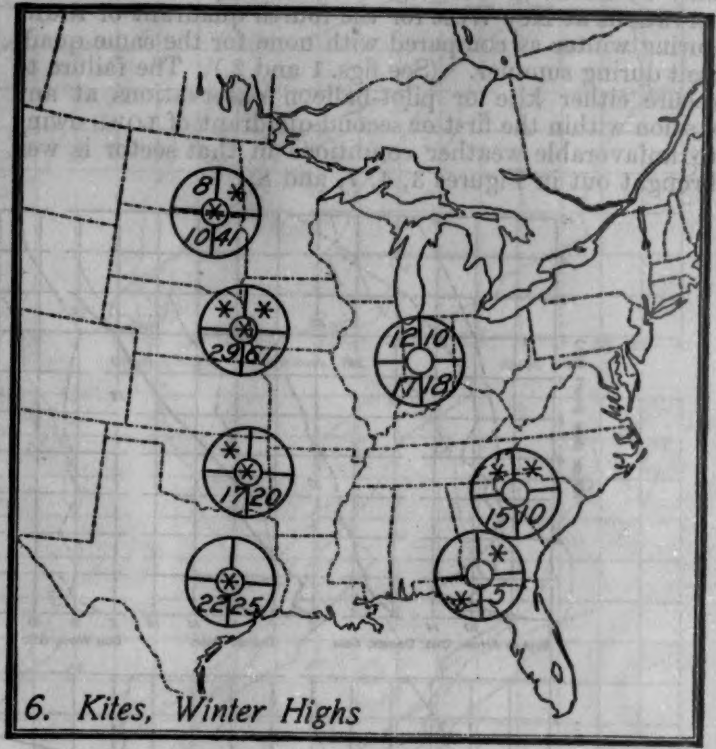


FIG. 6

FIG. 7

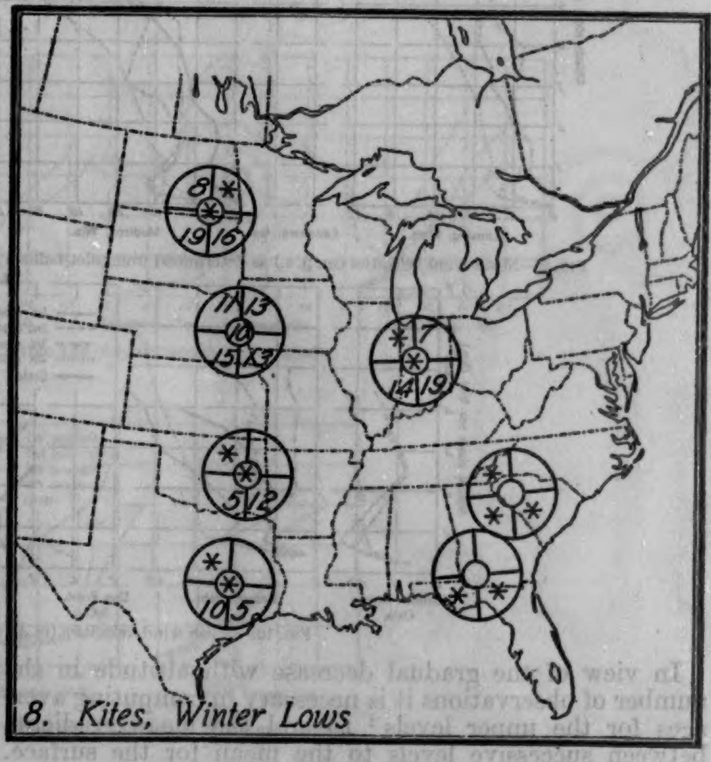


FIG. 8

The practicability of securing these observations, due to the seasonal variation in the tracks of HIGHS and LOWS, may be noted in the large number of pilot-balloon observations at Key West for the fourth quadrant of HIGHS during winter as compared with none for the same quadrant during summer. (See figs. 1 and 2.) The failure to secure either kite or pilot-balloon observations at any station within the first or second quadrant of LOWS owing to unfavorable weather conditions in that sector is well brought out in Figures 3, 4, 7, and 8.

Mean wind velocities and directions as determined from both kite and pilot-balloon observations separately have been included for the following reasons:

1. Since all of these observations were made under special weather conditions, any inherent characteristics of either method will therefore be more conspicuous than if made under a variety of pressure types.

2. The kite observations outnumber the balloon observations in certain quadrants, but the latter extend in general to greater heights.

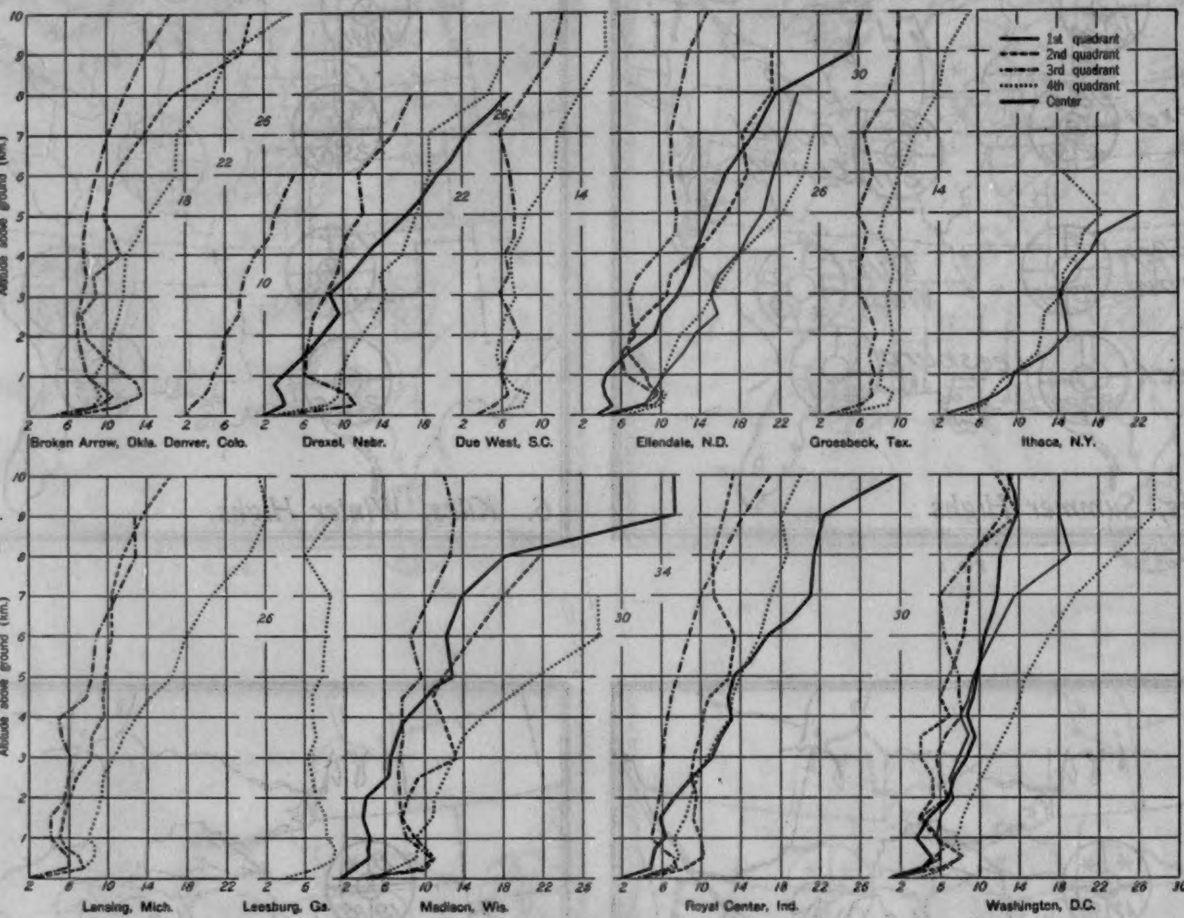


FIG. 9.—Mean wind velocities (m. p. s.) as determined from pilot-balloon observations in various quadrants of well-pronounced HIGHS during summer

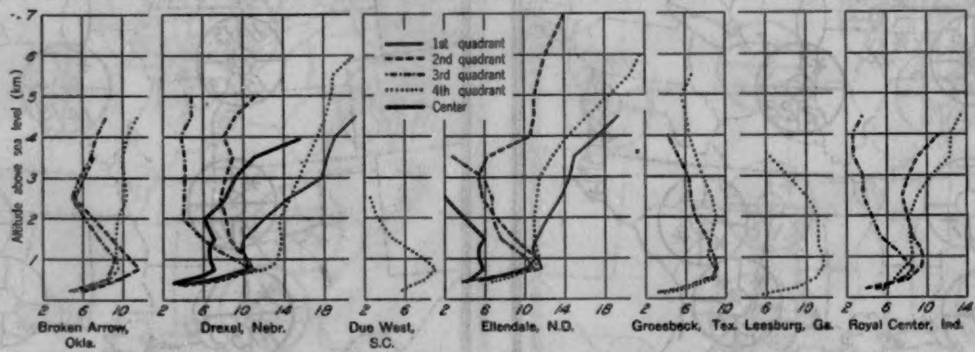


FIG. 10.—Mean wind velocities (m. p. s.) from kite observations in summer HIGHS

In view of the gradual decrease with altitude in the number of observations it is necessary in computing averages for the upper levels [1] to add the mean gradients between successive levels to the mean for the surface.

It is believed that data of this nature are most advantageously analyzed when viewed graphically. Numerous graphs are therefore reproduced and tables omitted or condensed so far as practicable.

3. Certain quadrants at some of the stations are represented by kite observations only, other quadrants by balloon observations alone. By having both sets in these cases, all possible quadrants are included.

WIND VELOCITY

The mean wind velocities determined from pilot-balloon and kite observations in various quadrants of HIGHS and LOWS for summer and winter are shown in Figures 9 to 16, inclusive.

[1] The general terms, "lower" and "upper" levels of HIGHS and LOWS are frequently used throughout this paper and although the dividing level between these two regions is arbitrary it refers, in general, to an altitude between 1 and 2 km.

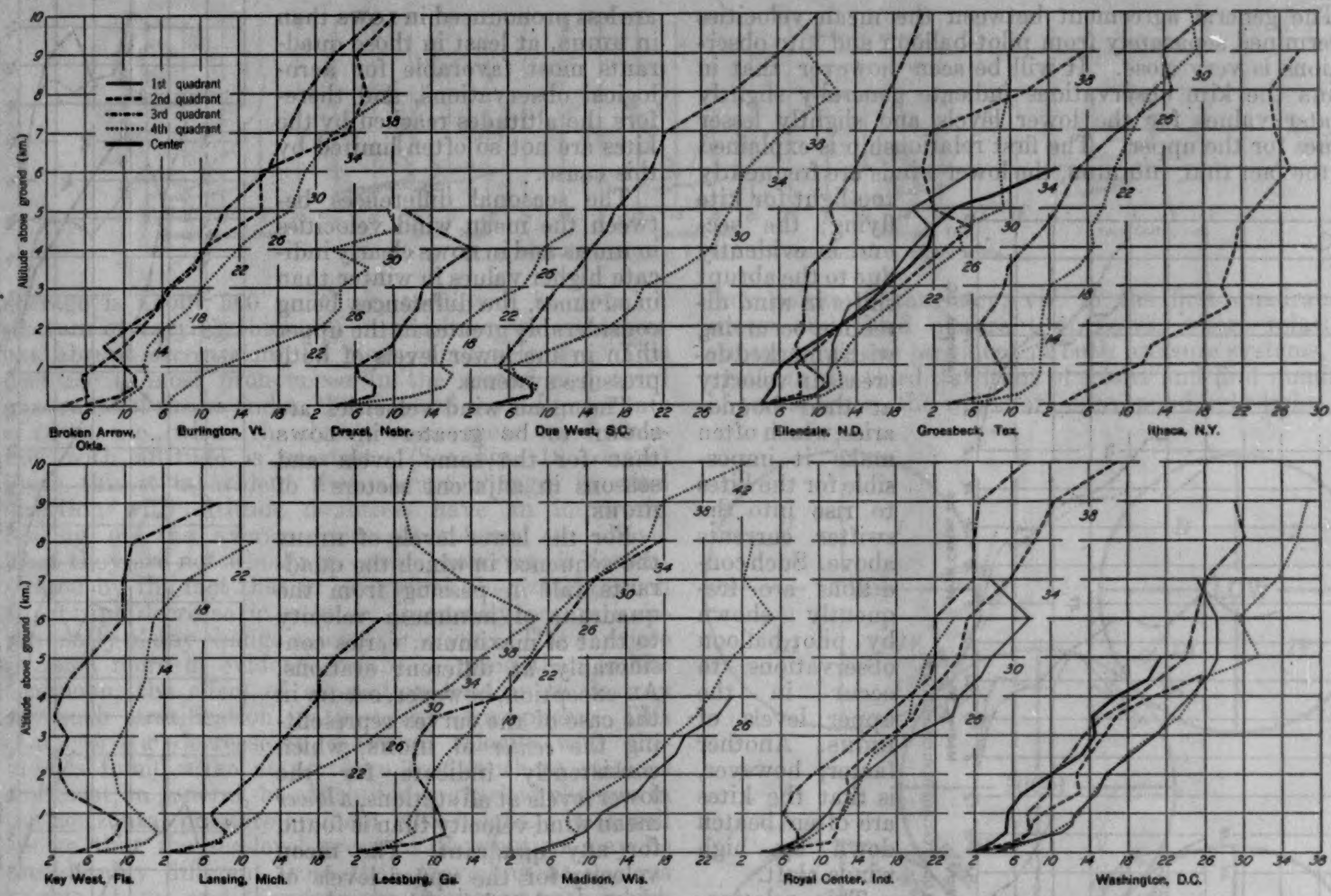


FIG. 11.—Mean wind velocities (m. p. s.) from pilot-balloon observations in winter HIGHS

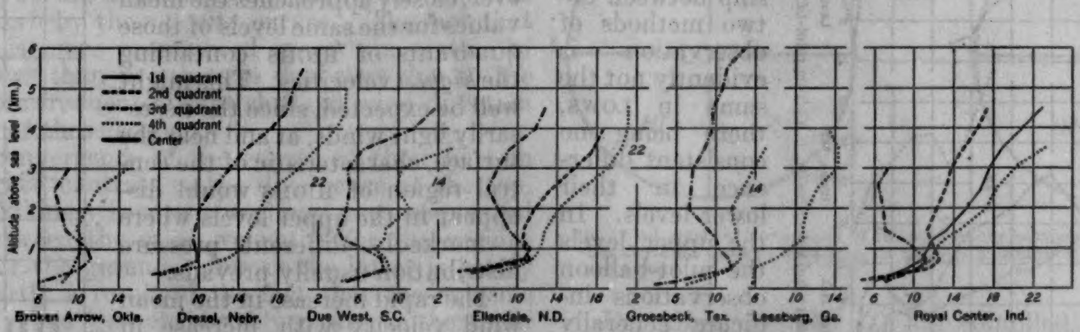


FIG. 12.—Mean wind velocities (m. p. s.) from kite observations in winter HIGHS

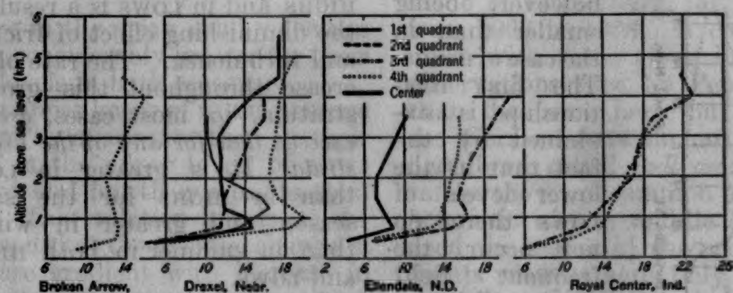


FIG. 14.—Mean wind velocities (m. p. s.) from kite observations in summer LOWS

The general agreement between the mean velocities determined separately from pilot-balloon and kite observations is very close. It will be seen however that in HIGHS the kite observations indicate generally slightly greater values for the lower levels and slightly lesser values for the upper. The first relationship is explained by the fact that in HIGHS, the lower winds are frequently too light for kite flying; the second is evidently due to the abrupt shifts in wind direction occurring with a marked decrease in velocity at their boundaries, which often make it impossible for the kites to rise into the swifter currents above. Such conditions are frequently shown by pilot-balloon observations to occur in the upper levels of HIGHS. Another factor, however, is that the kites are often beaten down by high winds aloft.

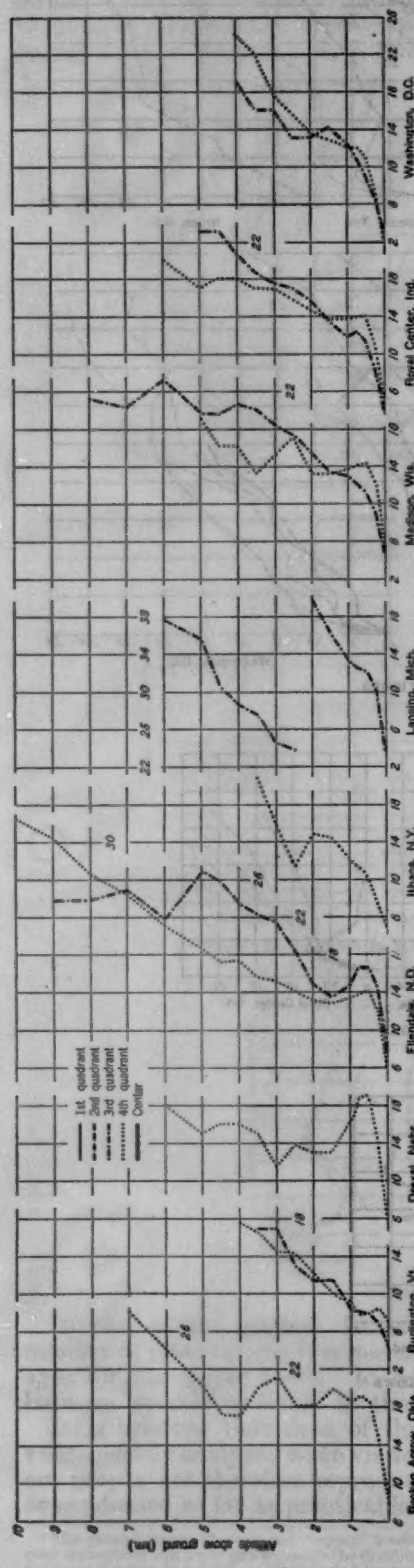


FIG. 13.—Mean wind velocities (m. p. s.) from pilot-balloon observations in summer LOWS

This relationship between the two methods of observation is evidently not the same in LOWS, there being no consistent difference in their lower levels. In the upper levels the pilot-balloon observations indicate generally higher values, the differences, however, being smaller than in the case of HIGHS. The first relationship is explained by the fact that in the lower levels of LOWS there do not occur the frequent light winds which prevent kite flights as is the case in HIGHS; as to the second relationship, it seems that abrupt shifts in wind direction are less pronounced in LOWS than in HIGHS, at least in those quadrants most favorable for aerological observations, and therefore the altitudes reached by the kites are not so often limited by this cause.

The seasonal differences between the mean wind velocities in HIGHS and in LOWS clearly indicate higher values in winter than in summer, the differences being considerably greater in the upper than in the lower levels of both pressure systems.

The mean wind velocities are shown to be greater in LOWS than for the same levels and seasons in adjacent sectors[2] of HIGHS.

For the lower levels of HIGHS the sequence in which the quadrants fall in passing from the quadrant of minimum velocity to that of maximum, varies considerably at different stations. An exception, however, occurs in the case of the curves representing the *center* of HIGHS, which consistently indicate for the lower levels at all stations, a *lower* mean wind velocity than is found for any quadrant. The mean velocity for the upper levels of the central region of HIGHS, however, closely approaches the mean values for the same levels of those quadrants of HIGHS containing the *highest* velocities. This might well be expected, since the necessarily light winds, at and near the surface, characteristic of the central region of HIGHS would disappear in the upper levels where a markedly different pressure distribution usually prevails.

The rapid increase in the mean wind velocity with increase in height through the first few hundred meters above ground in HIGHS and in LOWS is a result of the diminishing effect of friction and turbulence. The rate of increase throughout this ground stratum, in most cases, *greatly exceeds that for any of the higher strata.* It is greater in LOWS than in HIGHS for the same season and greater in winter than in summer in both HIGHS and LOWS.

Immediately above this ground layer, which on the

[2] The term "adjacent sectors" is used here to designate those regions of HIGHS and LOWS wherein the same general wind direction in their lower levels is indicated, i. e., the front sector of HIGHS and the rear sector of LOWS, wherein, this direction is northerly and, the rear sector of HIGHS and the front sector of LOWS wherein, this direction is southerly.

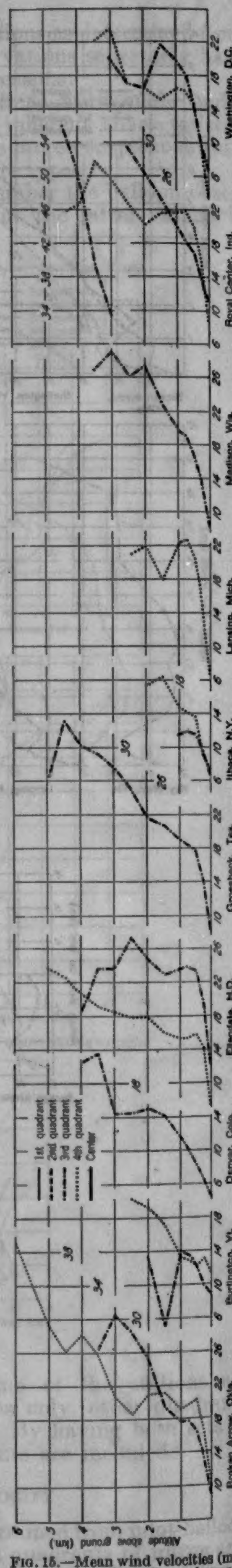


FIG. 15.—Mean wind velocities (m. p. s.) from pilot-balloon observations in winter LOWS

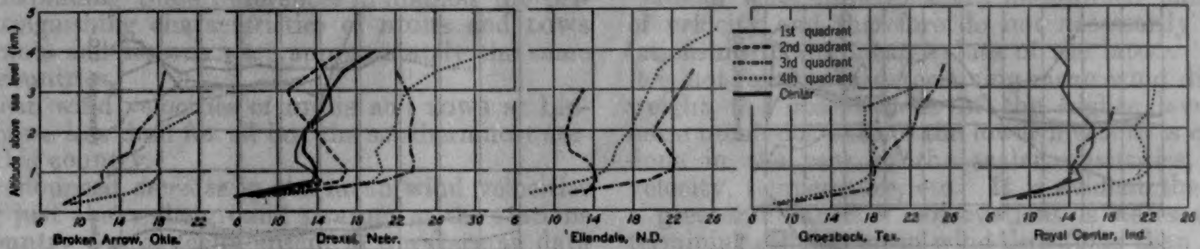


FIG. 16.—Mean wind velocities (m. p. s.) from kite observations in winter LOWS

average is about 500 m. thick, there will be noted a stratum of varying thickness in which occurs a more or less abrupt *decrease* in the mean wind velocity. This decrease is most pronounced in the second and third quadrants of HIGHS and in the first and second quadrants of LOWS, i. e., where the change in the mean wind direction with altitude is greatest. (See figs. 18 to 25.) From this it is evident that abrupt changes in wind direction with altitude doubtless have an important bearing on the average decrease referred to above. That they are not wholly the cause, however, is demonstrated by the fact that in individual observations such an abrupt decrease in velocity frequently occurs independently of any change in wind direction. This decrease is much more in evidence in the morning than in the afternoon, the effect of convection tending to destroy any such stratification in the lower atmosphere. This characteristic decrease in the wind velocity with altitude is found alike at northern and southern stations and must, in general, be attributed to marked changes in the horizontal pressure gradient with height. It is well known that the sea-level pressure distribution may be considerably different from that prevailing at various heights above, and therefore the frequency with which this difference occurs must influence the mean values to the extent shown by the velocity curves. The fact that this decrease is more pronounced in certain sectors of HIGHS and LOWS than in others is doubtless due to the larger and more frequent abrupt shifts in wind direction characteristic of those sectors.

The close convergence of the curves at their bottom stands in marked contrast to the divergence at the top. The former strikingly reveals the almost inconsequential differences between the mean velocities for the various quadrants near the ground, whereas the latter is partly actual and partly a result of the fact that the extreme range in wind velocity is considerably greater in the upper levels than in the lower and therefore a greater number of observations are required to determine the *true* mean for the higher levels.

The latitudinal differences in the mean wind velocities in both HIGHS and LOWS are considerably greater for their upper than for their lower levels in both seasons.

The wind velocities in the upper levels of HIGHS average higher in their first and fourth quadrants than in their second and third, whereas in the upper levels of LOWS they are higher in the third and fourth quadrants than in the first and second. This relationship is to be expected since it is well known that the average change in the direction of the pressure gradient with increase in elevation (as indicated by the average wind directions) is considerably *less* in the first and fourth quadrants of HIGHS and in the third and fourth quadrants of LOWS than in the second and third quadrants of HIGHS and in the first and second quadrants of LOWS.

The relationship between HIGHS and LOWS, in this connection, is shown graphically in Figure 17, where it may be seen that agreement occurs at but two of the four points of tangency, viz, in the first quadrant of HIGHS and third quadrant of LOWS, where relatively strong winds are prevalent in both pressure systems, and again, in the third quadrant of HIGHS and first quadrant of LOWS, where the winds are correspondingly light.

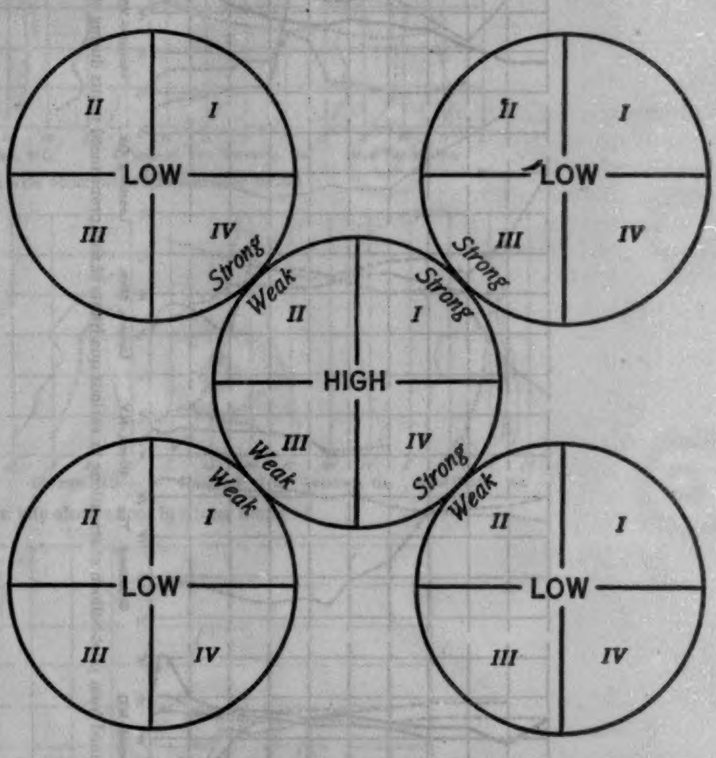


FIG. 17.—A graphical comparison of the relationship between the mean wind velocities above the gradient wind level for adjacent quadrants of well pronounced HIGHS and LOWS

Dr. Albert Peppler (*1*) has compiled the mean wind velocities and gradients for the various quadrants of HIGHS and LOWS as obtained from kite observations made at Lindenburg, lat. N. 52° 10′; long. E. 14° 15′, from 1903 to 1908. A comparison of these results was made with those given in this paper. The number of observations used by Peppler was considerably greater than that used here, but it must be remembered that the German data do not strictly represent what have here been called *well-pronounced* HIGHS and LOWS but rather the more common but less pronounced types characteristic of the middle latitudes. Moreover, Peppler used the *means* of the ascents and descents of the kite flights whereas here, only the ascents have been used.

A close parallelism between the two sets of data is further made improbable owing to the fact that in the German study the pressure areas were divided into N., W., S., and E. quadrants while in this study the NE., NW., SW., and SE. quadrants were used. It would seem that in general with the former division the trajectories of the air currents would show greater diversity in the individual quadrants than with the latter.

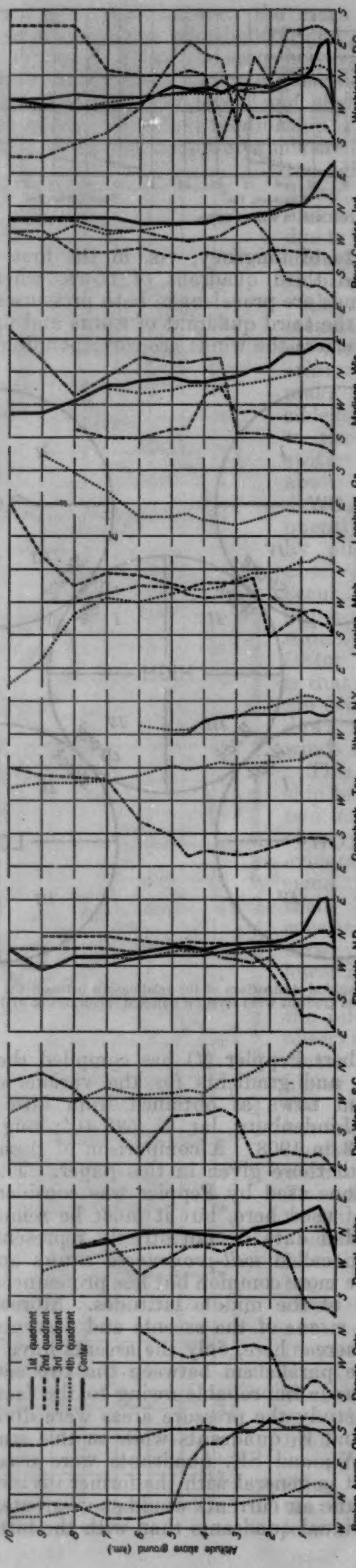


FIG. 18.—Mean wind directions determined from pilot-balloon observations in various quadrants of well pronounced HIGHS during summer

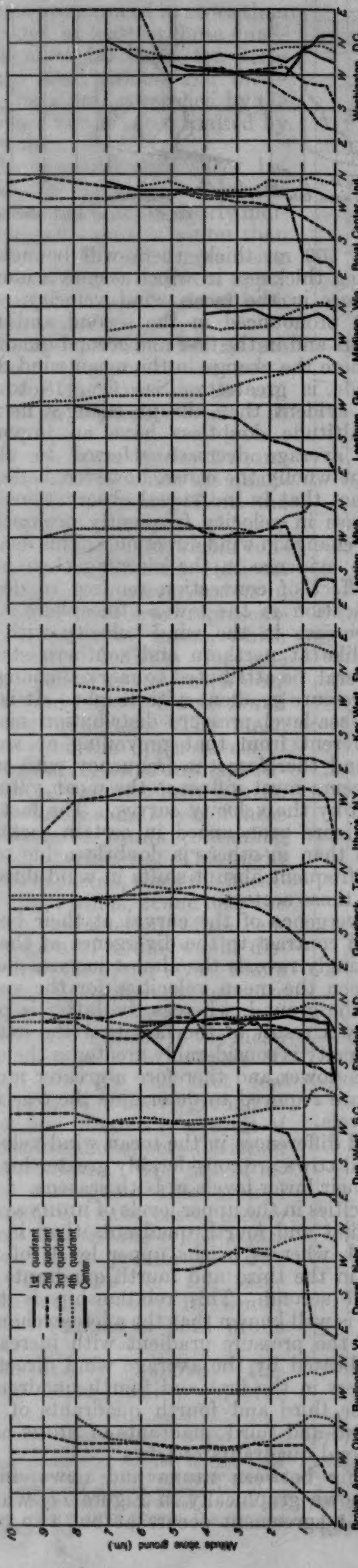


FIG. 20.—Mean wind directions from pilot-balloon observations in winter HIGHS

Notwithstanding these differences in method the primary distinguishing characteristics of HIGHS and LOWS by quadrants and seasons were approximately the same for both countries.

The mean wind velocities of HIGHS and LOWS at Lindenburg were less than for all but the southernmost stations in this country.

The pronounced *decrease* in the mean wind velocities occurring just above the ground stratum at the stations in this country is practically absent in the German data

Mean wind directions are determined independently of velocity and therefore do not necessarily bear a relationship to the mean values of the latter. Moreover, it is not feasible in determining mean wind directions to weight the observations of the higher levels by the more numerous ones of the lower levels as is customarily done in the case of the scalar quantities, viz, wind velocity, temperature, etc. It is evident therefore that a greater number of observations is necessary for determining reliable mean wind directions than for obtain-

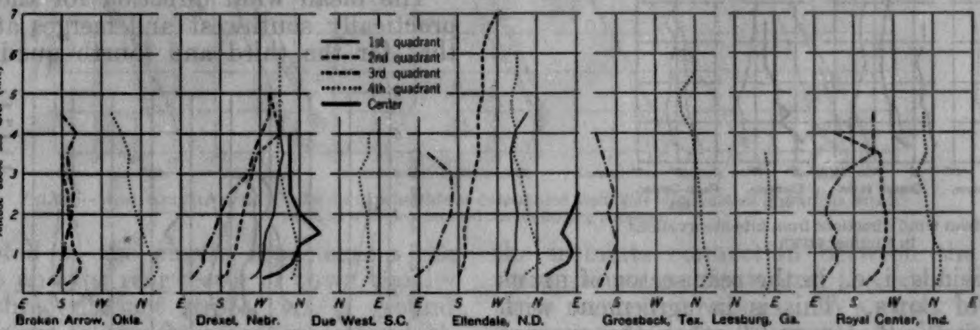


FIG. 19.—Mean wind directions from kite observations in summer HIGHS

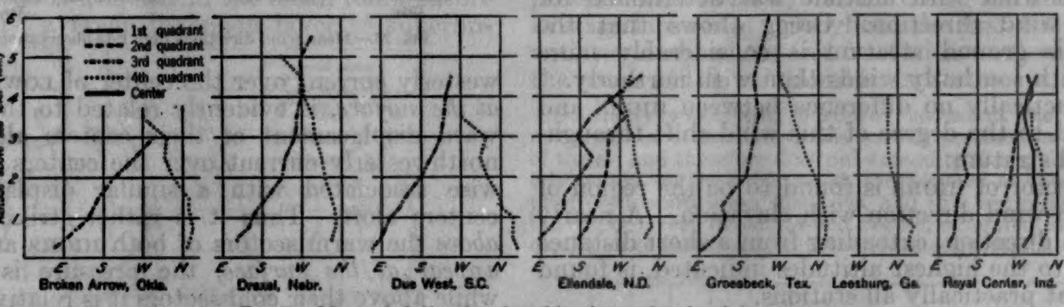


FIG. 21.—Mean wind directions from kite observations in winter HIGHS

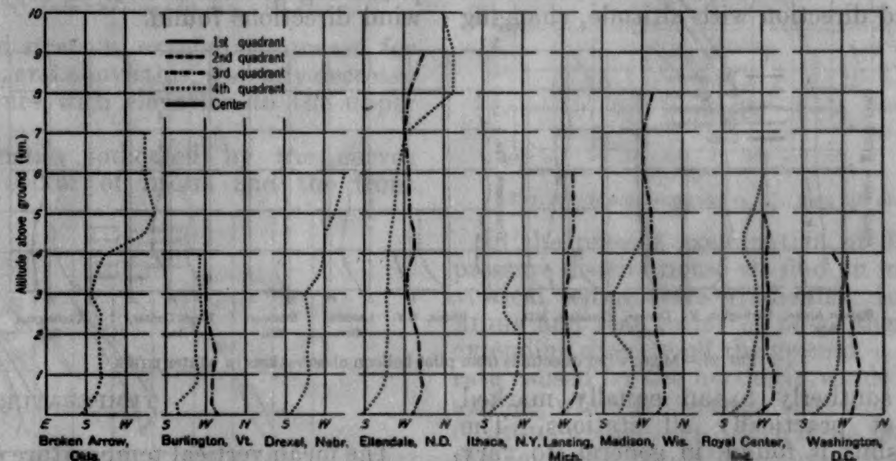


FIG. 22.—Mean wind directions from pilot-balloon observations in summer LOWS

wherein only a falling off or retardation in the *rate of increase* with elevation at these levels occurs.

Peppler calls attention to the fact that the vertical wind gradients of the various quadrants clearly demonstrate the unsymmetrical structure of HIGHS and LOWS. This is likewise well brought out in the present paper in the graphs for winds as well as for the other elements.

WIND DIRECTION

The mean wind direction determined from pilot-balloon and kite observations in various quadrants of HIGHS and LOWS for summer and winter are shown in figures 18 to 25, inclusive.

ing mean wind velocities. The values here given however are believed reliable for the most part except in some cases at the higher levels where occasionally marked irregularities in the direction graphs occur.

It is found that there is a generally greater divergence at the upper ends of the wind direction curves representing kite observations than at the corresponding levels of those representing pilot balloon observations. This is due to the fact that when the wind makes an abrupt shift the balloon immediately adjusts itself to the new direction, whereas more time is required for the kite and, in fact, the latter is frequently unable to rise into the upper current. We conclude, therefore, that the mean wind directions indicated by pilot-balloon

observations are more truly representative than are those obtained with kites.

The ground stratum in HIGHS and LOWS, i. e., the first few hundred meters wherein a marked increase in the mean wind velocity was noted, is found to contain a pronounced *veering* of the wind with altitude. This shift with elevation is greatest in those quadrants con-

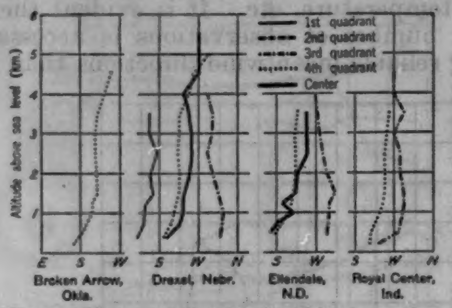


FIG. 23.—Mean wind directions from kite observations in summer LOWS

taining southerly winds, i. e., in the rear sector of HIGHS and front sector of LOWS. This is in agreement with results obtained by W. R. Gregg (*2*) when the average turning of the wind with altitude was determined for each surface wind direction. Gregg shows that the veering in this ground stratum is considerably more pronounced with southerly winds than with northerly.

There is practically no difference between HIGHS and LOWS in regard to the degree of this wind shift throughout the ground stratum.

The front sector of HIGHS is found to be the region of least change in wind direction with elevation. A nearly constant mean direction, extending from a short distance above ground to the highest altitudes indicated, is found in this sector at practically all stations.

The third quadrant of HIGHS contains the maximum shift in the mean wind direction with altitude, changing from a pronounced southerly to an equally marked northerly direction at practically all stations. The mean height of this shift is found, in general, to vary inversely with latitude, being highest at Key West, but at all stations it is lower in winter than in summer. At some of the stations this transition is indicated in the means by an abrupt shift while at others it is more or less gradual.

The mean wind directions in HIGHS at Ellendale, the northernmost station, are practically the same above 2 km., for all quadrants including the central region. In general, a common mean wind direction in all quadrants of HIGHS at any station is reached at successively greater heights from northern to southern stations.

Free air data for the first and second quadrants of LOWS are comparatively meager, but from those available it is evident that a marked difference in the mean wind direction between these two quadrants persists to at least 4 km. The first quadrant maintains a large south component, while the second quadrant has an equally pronounced north component to this height. (See fig. 25.)

It is evident that a common mean wind direction, containing a large west component, obtains in the upper levels of the third and fourth quadrants of LOWS commencing at a height varying at the different stations from 2 to 3 km. in winter and from 3 to 5 km. in summer. At the northern stations this mean direction is slightly north of west, whereas, at the southern stations, a small south component is evident.

The mean wind direction for the center of LOWS is practically southwest and merges at about 4 km. with that for the third and fourth quadrants. This south-

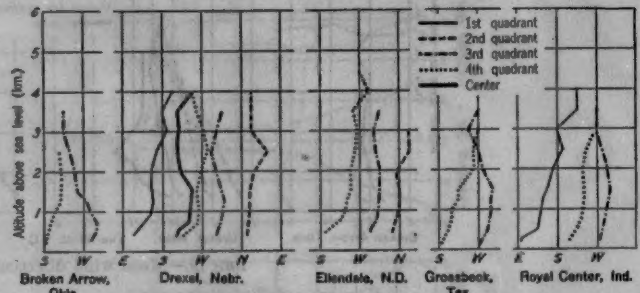


FIG. 25.—Mean wind directions from kite observations in winter LOWS

westerly current over the center of LOWS, *as they appear at the surface*, is evidently related to the frequent westward displacement of their centers aloft, whereas the northwesterly current over the centers of HIGHS is likewise associated with a similar displacement of their centers aloft. Thus it is rather strikingly shown that *above* the warm sectors of both HIGHS and LOWS, *as they appear at the surface*, the pressure is relatively high while above their cold sectors it is relatively low, thereby producing gradients aloft in accordance with the mean wind directions found.

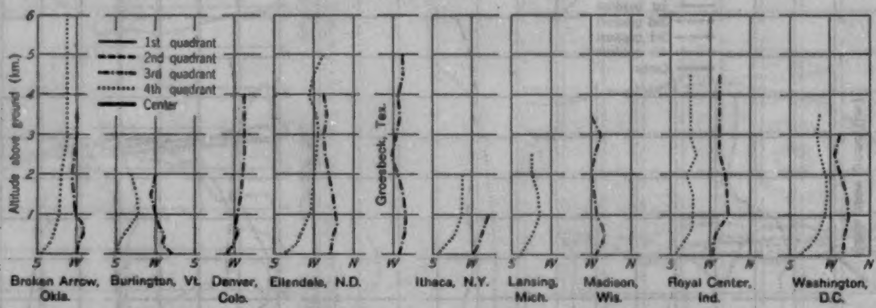


FIG. 24.—Mean wind directions from pilot-balloon observations in winter LOWS

TEMPERATURE

The mean vertical temperature distribution for various quadrants of HIGHS and LOWS for summer and winter are shown in Figures 26 to 29, inclusive.

As might be expected in a classification of well-pronounced pressure areas there occur marked differences in characteristics between the average lapse rate curves, particularly between those representing HIGHS as compared with LOWS. Differences between the respective front and rear sectors of each pressure system as well as marked seasonal diversities are likewise evident. In general these differences are more pronounced at the northern stations than at the southern, although certain variations occur in the curves for individual stations. The numerous details presented in the various graphs and tables prohibit reference to all in this discussion.

The principal characteristics of the average lapse rate curves are probably best ascertained by comparing these

for adjacent sectors of both pressure systems, i. e., the front sector of HIGHS with the rear sector of LOWS, and vice versa. In this way the wind streams (in the lower levels) are of the same general direction, viz, northerly in the one case and southerly in the other.

A comparison of the average *positive* lapse rate characteristic of the ground stratum in the front sector of HIGHS and rear sector of LOWS with the average *negative* lapse rate found in the lower stratum of the front sector of LOWS and rear sector of HIGHS strikingly brings out

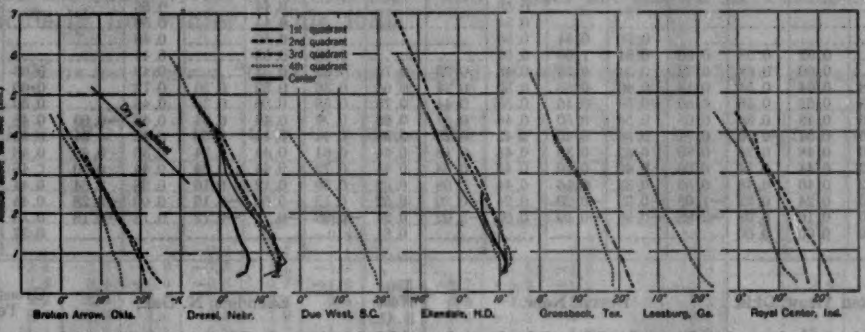


FIG. 26.—Mean temperatures, °C., for various heights as determined from kite observations in various quadrants of well-pronounced HIGHS during summer

There will be noted in the curves representing the front sector of HIGHS and the rear sector of LOWS, particularly for winter, three distinct strata, viz, a ground layer extending upward a few hundred meters which contains a conspicuous decrease in the mean temperature with altitude; an "average inversion layer"[3] superimposed upon the ground stratum, extending upward for several hundred meters, and above this, a steady decrease in the mean temperature with elevation to the upper limits of observation.

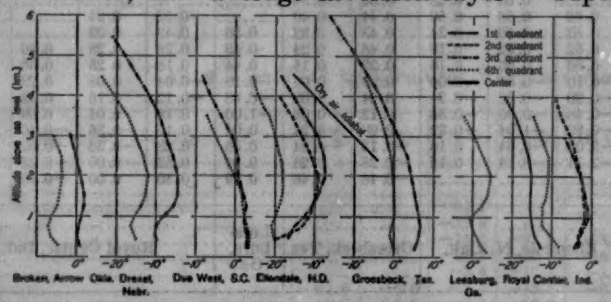


FIG. 27.—Mean temperatures, °C., from kite observations in winter HIGHS

The chief characteristics indicated by the curves representing the rear sector of HIGHS and the front sector of LOWS (i. e., the regions containing southerly winds in their lower levels) are an average inversion layer extending from the ground to several hundred meters above, following which there occurs a relatively marked decrease in the mean temperature with height which continues to the upper limits of observation.

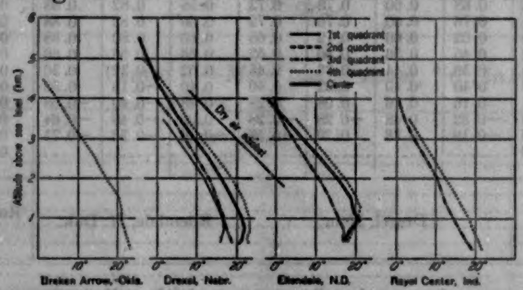


FIG. 28.—Mean temperatures, °C., from kite observations in summer LOWS

[3] The term "average inversion layer" as here used must not be construed as necessarily meaning the average of a series of observations, *all* of which indicated inversions, but, instead, the net result of a series which indicated both inversions and noninversions. It has been suggested by Dr. B. M. Varney that the term "statistical" might appropriately be used to designate any such results as the lapse rates here considered, in which the observations are combined to form an "inversion," which is such because in the statistical result the inversions outweigh the noninversions. The statistical inversion is thus the same sort of useful fiction as the "statistical cyclone" which British meteorologists have recently employed to designate such cyclones as, for instance, the Iceland LOW, which appears on our annual charts in the guise of reality because the traveling low pressure areas which pass through that region considerably outweigh in frequency or intensity or both the high pressure areas.

the intimate connection between the average vertical temperature gradients and the wind directions found in these respective regions. In a study of free air temperatures in relation to wind direction (without reference to pressure distribution) W. R. Gregg (*3*) showed that the average lapse rate throughout the first 500 m., is *greatest* with *northerly* winds and *least* with *southerly*. Discussing the cause of this relationship he states:

> Southerly winds are, of course, cooled at the surface as they move to higher latitudes; this cooling produces a stable condition of the air and therefore does not extend to the upper levels. Northerly winds, on the other hand, are warmed at the surface in their progress toward lower latitudes, and this warming *does* extend to the upper levels, in diminished degree, of course, since it tends to a condition of instability and therefore convectional activity sets in.

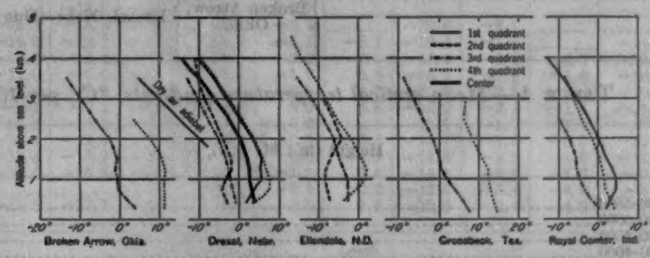


FIG. 29.—Mean temperatures, °C., from kite observations in winter LOWS

In the present examination of data (for well-marked pressure distributions) we find an intensification of these vertical temperature gradients. In the front sector of HIGHS and rear sector of LOWS there accordingly occur, extending directly off the ground, a *positive* average lapse rate caused by the northerly winds being warmed at the surface, while in the front sector of LOWS and rear sector of HIGHS a *negative* average lapse rate is found caused by the southerly winds being cooled at the surface. (See figs. 27 and 29.)

Furthermore, a pronounced latitudinal effect is evident in the increasing thickness of this ground stratum for winter HIGHS, ranging from about 300 m. at Ellendale, to about 900 m. at Leesburg.

The average inversion layer found superimposed upon this ground stratum, in the case of northerly winds, is a phenomenon usually associated with pronounced high-pressure areas particularly in winter and is evidence of the high degree of stability occurring under these conditions. It is frequently found that the wind direction indicates an appreciably *different* trajectory of the air in this stratum as compared to that of the relatively colder air beneath.

The average vertical temperature gradients in HIGHS and LOWS for summer and winter are shown in Tables 2 to 5, inclusive.

TABLE 2.—*Mean vertical temperature gradients, °C., per 100 m., in various quadrants of well-pronounced "highs" during summer*

Height (m.) M. S. L.	II Q.	III Q.	IV Q.	I Q.	II Q.	III Q.	IV Q.	Center	IV Q.	I Q.	II Q.	III Q.	IV Q.	Center	III Q.	IV Q.	IV Q.	II Q.	III Q.	IV Q.
6,500-7,000											0.46									
6,000-6,500											0.44									
5,500-6,000							0.58				0.44		0.56							
5,000-5,500							0.54				0.44		0.56			0.40				
4,500-5,000					0.70	0.44	0.56				0.56		0.48			0.44				
4,000-4,500		0.52	0.58	0.60	0.64	1.00	0.54			0.48	0.58		0.44			0.24			0.56	0.70
3,500-4,000		0.60	0.68	0.32	0.34	0.58	0.48	0.28	0.70	0.32	0.52		0.48		0.60	0.62		0.16	0.54	0.70
3,000-3,500	0.48	0.64	0.54	0.18	0.40	0.50	0.50	0.24	0.68	0.36	0.52	0.56	0.72		0.60	0.60	0.60	0.60	0.50	0.40
2,500-3,000	0.58	0.62	0.36	0.50	0.56	0.46	0.50	0.44	0.78	0.58	0.50	0.38	0.48		0.50	0.46	0.38	0.64	0.40	0.40
2,000-2,500	0.46	0.48	0.38	0.68	0.58	0.50	0.44	0.44	0.66	0.72	0.44	0.34	0.48	−0.06	0.48	0.34	0.48	0.54	0.5[illegible]	0.30
1,500-2,000	0.60	0.54	0.30	0.74	0.56	0.40	0.42	0.28	0.58	0.44	0.44	0.38	0.42	0.34	0.52	0.28	0.60	0.56	0.24	0.22
1,250-1,500	0.60	0.48	0.24	0.80	0.52	0.36	0.48	0.48	0.44	0.64	0.44	0.24	0.36	0.60	0.48	0.28	0.56	0.68	0.32	0.20
1,000-1,250	0.52	0.44	0.24	0.60	0.40	0.20	0.44	0.68	0.44	0.72	0.44	0.24	0.44	0.60	0.48	0.40	0.64	0.60	0.40	0.40
750-1,000	0.52	0.40	0.48	0.56	0.32	0.16	0.44	0.08	0.32	0.56	0.12	0.16	0.28	0.64	0.44	0.44	0.36	0.48	0.40	0.40
500-750	0.56	0.24	0.32	−1.08	−0.32	−0.20	0.24	−0.20	0.52	0.12	−0.60	−0.16	0.00	−0.28	0.44	0.36	0.60	0.40	0.20	0.60
250-500	0.80	0.16	0.08	−2.88	−0.96	−0.19	0.00	−2.02	0.24	−0.93	−0.72	−0.72	0.18	−0.18	0.36	0.00	0.76	0.44	0.16	1.00
Surface-250	0.59	0.00	0.00						0.61						0.37	−0.09	1.15	0.40	0.40	1.20
	Broken Arrow, Okla.			Drexel, Nebr.					Due West, S. C.	Ellendale, N. Dak.					Groesbeck, Tex.		Leesburg, Ga.	Royal Center, Ind.		

TABLE 3.—*Mean vertical temperature gradients, °C., per 100 m., in various quadrants of well-pronounced "highs" during winter*

Height (m.) M. S. L.	III Q.	IV Q.	III Q.	IV Q.	III Q.	IV Q.	II Q.	III Q.	IV Q.	III Q.	IV Q.	IV Q.	I Q.	II Q.	III Q.	IV Q.
5500-6000										0.68						
5000-5500			0.68							0.68						
4500-5000			0.56							0.62						
4000-4500			0.66	0.68	0.46			0.66	0.28	0.56	0.38					
3500-4000			0.46	0.60	0.56		0.62	0.56	0.50	0.44	0.40		0.52	0.24		
3000-3500			0.34	0.44	0.54	0.36	0.52	0.66	0.34	0.48	0.32	0.56	0.42	0.52		0.44
2500-3000	0.26	0.40	0.34	0.40	0.24	0.48	0.52	0.32	0.18	0.46	0.24	0.48	0.28	0.28	0.40	0.38
2000-2500	0.26	0.06	0.24	0.26	0.02	0.54	0.36	0.06	0.18	0.22	0.14	0.44	0.18	0.28	0.36	0.04
1500-2000	0.18	−0.12	0.00	−0.14	0.26	0.34	−0.10	−0.34	−0.06	0.20	0.06	−0.18	−0.04	0.08	0.28	−0.10
1250-1500	−0.04	−0.24	−0.36	−0.44	0.24	0.12	−0.20	−0.56	−0.24	0.24	0.08	−0.68	−0.12	0.16	0.12	−0.44
1000-1250	−0.28	−0.64	−1.04	−0.72	−0.12	0.16	−0.48	−0.80	−0.36	0.12	−0.08	−1.00	0.16	0.04	0.08	−0.04
750-1000	−0.28	−0.36	−0.68	−0.36	0.04	0.24	−0.80	−1.04	−0.32	0.08	−0.24	0.04	0.12	−0.36	−0.40	0.12
500-750	−0.12	0.28	−0.04	0.36	0.16	0.20	−2.08	−0.64	0.16	−0.12	−0.24	0.36	0.28	−0.36	−0.52	0.64
250-500	0.20	0.84	0.19	0.58	−0.08	−0.04	−2.14	−0.54	0.18	−0.28	0.28	0.64	0.52	0.00	−0.32	0.92
Surface—250	0.59	0.59			0.00	−0.30				−0.46	0.46	0.70	0.80	0.00	−0.80	0.80
	Broken Arrow, Okla.		Drexel, Nebr.		Due West, S. C.		Ellendale, N. Dak.			Groesbeck, Tex.		Leesburg, Ga.	Royal Center, Ind.			

TABLE 4.—*Mean vertical temperature gradients, °C., per 100 m., in various quadrants of well-pronounced "lows" during summer*

Height (m.) M. S. L.	IV Q.	I Q.	III Q.	IV Q.	Center	III Q.	IV Q.	Center	III Q.	IV Q.
5000-5500					0.42					
4500-5000				0.76	0.48					
4000-4500	0.68			0.80	0.56					
3500-4000	0.66		0.82	0.64	0.66	0.40		0.90	0.32	
3000-3500	0.64	0.68	0.60	0.70	0.72	0.58	0.82	0.88	0.54	0.60
2500-3000	0.64	0.76	0.60	0.76	0.72	0.60	0.82	0.88	0.56	0.58
2000-2500	0.60	0.62	0.60	0.72	0.68	0.66	0.80	0.88	0.52	0.58
1500-2000	0.62	0.46	0.36	0.50	0.52	0.56	0.56	0.60	0.34	0.58
1250-1500	0.20	0.56	0.44	0.36	0.48	0.52	0.32	0.36	0.40	0.60
1000-1250	0.00	0.40	0.40	0.32	0.40	0.40	−0.16	0.52	0.60	0.56
750-1000	0.24	0.16	0.16	0.08	0.28	0.48	−0.40	−0.68	0.56	0.40
500-750	0.36	−0.32	0.48	−0.28	−0.28	0.00	−0.48	−0.64	0.56	0.36
250-500	0.28	−0.19	0.38	0.29	−0.58	−0.18	−0.36	−0.71	0.76	0.52
Surface-250	0.58								0.80	0.40
	Broken Arrow, Okla.	Drexel, Nebr.				Ellendale, N. Dak.			Royal Center, Ind.	

TABLE 5.—*Mean vertical temperature gradients, °C., per 100 m., in various quadrants of well-pronounced "lows" during winter*

Heights (m.) M. S. L.	III Q.	IV Q.	I Q.	II Q.	III Q.	IV Q.	Center	II Q.	III Q.	IV Q.	III Q.	IV Q.	I Q.	III Q.	IV Q.
4,000-4,500										0.50					
3,500-4,000			0.84	0.16		0.80	0.90			0.62			0.74		
3,000-3,500	0.70		0.66	0.30	0.56	0.72	0.78		0.74	0.64	0.52		0.80		0.40
2,500-3,000	0.70		0.66	0.52	0.54	0.60	0.82	0.50	0.64	0.56	0.52	−0.10	0.62		0.44
2,000-2,500	0.78	0.84	0.60	0.44	0.52	0.56	0.48	0.40	0.52	0.66	0.52	0.38	0.44	0.58	0.48
1,500-2,000	0.34	0.60	0.46	0.40	0.38	0.44	0.36	−0.52	0.26	0.56	0.22	0.52	0.38	0.36	0.42
1,250-1,500	−0.12	0.32	−0.08	0.04	0.20	0.52	0.28	−0.48	0.36	0.48	0.20	0.52	0.48	0.04	0.20
1,000-1,250	0.24	−0.12	0.12	−0.60	0.24	0.28	−0.04	0.00	0.48	−0.12	0.60	0.08	0.48	0.32	0.24
750-1,000	−0.08	0.04	−0.72	−0.32	0.28	0.00	0.28	0.20	−0.04	−0.80	0.76	0.12	−0.04	0.40	0.04
500-750	0.80	0.08	−0.68	0.32	0.12	−1.00	0.16	0.12	0.00	−1.24	0.72	0.32	−0.48	0.64	0.40
250-500	1.00	−0.12	−0.48	0.48	0.19	−1.83	0.29	0.54	0.00	−1.07	0.64	0.32	−0.36	0.84	0.52
Surface-250	1.18	0.00									0.55	0.27	−0.40	0.80	0.40
	Broken Arrow, Okla.		Drexel, Nebr.					Ellendale, N. Dak.			Groesbeck, Tex.		Royal Center, Ind.		

A marked decrease in the average lapse rates in both HIGHS and LOWS, especially in the former, is found in winter as compared with summer.

The average lapse rates of the upper levels of LOWS are greater than those for the same levels of HIGHS for the same seasons, particularly for winter. This indicates rather strikingly the comparatively steeper lapse rates occurring during conditions most favorable for precipitation.

The mean temperatures in HIGHS and LOWS for summer and winter are shown in Tables 6 to 9, inclusive.

TABLE 6.—*Mean temperatures, °C., in various quadrants of well-pronounced "highs" during summer*

Height (m.) M. S. L.	Broken Arrow, Okla. II Q.	Broken Arrow, Okla. III Q.	Broken Arrow, Okla. IV Q.	Drexel, Nebr. I Q.	Drexel, Nebr. II Q.	Drexel, Nebr. III Q.	Drexel, Nebr. IV Q.	Drexel, Nebr. Center	Due West, S. C. IV Q.	Ellendale, N. Dak. I Q.	Ellendale, N. Dak. II Q.	Ellendale, N. Dak. III Q.	Ellendale, N. Dak. IV Q.	Ellendale, N. Dak. Center	Groesbeck, Tex. III Q.	Groesbeck, Tex. IV Q.	Leesburg, Ga. IV Q.	Royal Center, Ind. II Q.	Royal Center, Ind. III Q.	Royal Center, Ind. IV Q.
7,000											−16.1									
6,500											−13.8									
6,000							−12.7				−11.6		−15.8							
5,500							−9.8				−9.4		−13.0			−1.9				
5,000					−7.0	−6.7	−7.1				−7.2		−10.2			0.1				
4,500		−0.4	−2.5	−3.9	−3.5	−4.5	−4.3			−7.6	−4.4		−7.8			2.3			−0.4	−6.0
4,000		2.2	0.4	−0.9	−0.3	0.5	−1.6	−5.2	−2.7	−5.2	−1.5		−5.6		3.8	3.5		4.3	2.4	−2.5
3,500	6.4	5.2	3.8	0.7	1.4	3.4	0.8	−3.8	0.8	−3.6	1.1	2.3	−3.2		6.8	6.6	4.2	5.1	5.1	1.0
3,000	8.8	8.4	6.5	1.6	3.4	5.9	3.3	−2.6	4.2	−1.8	3.7	5.1	0.4		9.8	9.6	7.2	8.1	7.6	3.0
2,500	11.7	11.5	8.3	4.1	6.2	8.2	5.8	−0.4	8.1	1.1	6.2	7.0	2.8	6.0	12.3	11.9	9.1	11.3	9.6	5.0
2,000	14.0	13.9	10.2	7.5	9.1	10.7	8.0	2.6	11.4	4.7	8.4	8.7	5.2	5.7	14.7	13.6	11.5	14.0	12.3	6.5
1,500	17.0	16.6	11.7	11.2	11.9	12.7	10.1	4.0	14.3	6.9	10.6	10.6	7.3	7.4	17.3	15.0	14.5	16.8	13.5	7.6
1,250	18.5	17.8	12.3	13.2	13.2	13.6	11.3	5.2	15.4	8.5	11.7	11.2	8.2	8.9	18.5	15.7	15.9	18.5	14.3	8.1
1,000	19.8	18.9	12.9	14.7	14.2	14.1	12.4	6.9	16.5	10.3	12.8	11.8	9.3	10.4	19.7	16.7	17.5	20.0	15.3	9.1
750	21.1	19.9	14.1	16.1	15.0	14.5	13.5	7.1	17.3	11.7	13.1	12.2	10.0	12.0	20.8	17.8	18.4	21.2	16.3	10.1
500	22.5	20.5	14.9	13.4	14.2	14.0	14.1	6.1	18.6	12.0	11.6	11.8	10.0	11.3	21.9	18.7	19.9	22.2	16.8	11.6
250	24.5	20.9	15.1						19.2						22.8	18.7	21.8	23.3	17.2	14.1
Surface	24.6	20.9	15.1	10.4	13.2	13.8	14.1	4.0	19.4	11.5	11.2	11.4	10.1	11.2	23.2	18.6	23.7	23.4	17.3	14.4

TABLE 7.—*Mean temperatures, ° C., in various quadrants of well-pronounced "highs" during winter*

Height (m.) M. S. L.	Broken Arrow, Okla. III Q.	Broken Arrow, Okla. IV Q.	Drexel, Nebr. III Q.	Drexel, Nebr. IV Q.	Due West, S. C. III Q.	Due West, S. C. IV Q.	Ellendale, N. Dak. II Q.	Ellendale, N. Dak. III Q.	Ellendale, N. Dak. IV Q.	Groesbeck, Tex. III Q.	Groesbeck, Tex. IV Q.	Leesburg, Ga. IV Q.	Royal Center, Ind. I Q.	Royal Center, Ind. II Q.	Royal Center, Ind. III Q.	Royal Center, Ind. IV Q.
6,000										−16.5						
5,500			−21.2							−13.1						
5,000			−17.8							−9.7						
4,500			−15.0	−23.9	−8.4			−18.8	−25.7	−6.6	−7.7					
4,000			−11.7	−20.5	−6.1		−19.3	−15.5	−24.3	−3.8	−5.8		−22.0	−9.1		
3,500			−9.4	−17.5	−3.3	−7.1	−16.2	−12.7	−21.8	−1.6	−3.8	−2.7	−19.4	−7.9		−14.9
3,000	−1.6	−6.0	−7.7	−15.3	−0.6	−5.3	−13.6	−9.4	−20.1	0.8	−2.2	0.1	−17.3	−5.3	−6.6	−12.7
2,500	−0.3	−4.0	−6.0	−13.3	0.6	−2.9	−11.0	−7.8	−19.2	3.1	−1.0	2.5	−15.9	−3.9	−4.6	−10.8
2,000	1.0	−3.7	−4.8	−12.0	0.7	−0.2	−9.2	−7.5	−18.3	4.2	−0.3	4.7	−15.0	−2.5	−2.8	−10.6
1,500	1.9	−4.3	−4.8	−12.7	2.0	1.5	−9.7	−9.2	−18.6	5.2	0.0	3.8	−15.2	−2.1	−1.4	−11.1
1,250	1.8	−4.9	−5.7	−13.8	2.6	1.8	−10.2	−10.6	−19.2	5.8	0.2	2.1	−15.5	−1.7	−1.1	−12.2
1,000	1.1	−6.5	−8.3	−15.6	2.3	2.2	−11.4	−12.6	−20.1	6.1	0.0	−0.4	−15.1	−1.6	−0.9	−12.3
750	0.4	−7.4	−10.0	−16.5	2.4	2.8	−13.4	−15.2	−20.9	6.3	−0.6	−0.3	−14.8	−2.5	−1.9	−12.0
500	0.1	−6.7	−10.1	−15.6	2.8	3.3	−18.6	−16.8	−20.5	6.0	−1.2	0.6	−14.1	−3.4	−3.2	−10.4
250	0.6	−4.6			2.6	3.2				5.3	−0.5	2.2	−12.8	−3.4	−4.0	−8.1
Surface	0.7	−4.5	−9.9	−15.0	2.6	3.1	−19.8	−17.1	−20.4	4.8	0.0	3.5	−12.6	−3.4	−4.2	−7.9

TABLE 8.—*Mean temperatures, ° C., in various quadrants of well-pronounced "lows" during summer*

Height (m.) M. S. L.	Broken Arrow, Okla. IV Q.	Drexel, Nebr. I Q.	Drexel, Nebr. III Q.	Drexel, Nebr. IV Q.	Drexel, Nebr. Center	Ellendale, N. Dak. III Q.	Ellendale, N. Dak. IV Q.	Ellendale, N. Dak. Center	Royal Center, Ind. III Q.	Royal Center, Ind. IV Q.
5,500					−4.9					
5,000				−3.1	−2.8					
4,500	1.1			0.7	−0.4					
4,000	4.5		−0.1	4.7	2.4	−0.6		−2.0	0.6	
3,500	7.8	1.6	4.0	7.9	5.7	1.4	5.1	2.5	2.2	3.7
3,000	11.0	5.0	7.0	11.4	9.3	4.3	9.2	6.9	4.9	6.7
2,500	14.2	8.8	10.0	15.2	12.9	7.3	13.3	11.3	7.7	9.6
2,000	17.2	11.9	13.0	18.8	16.3	10.6	17.3	15.7	10.3	12.5
1,500	20.3	14.2	14.8	21.3	18.9	13.4	20.1	18.7	12.0	15.4
1,250	20.8	15.6	15.9	22.2	20.1	14.7	20.9	19.6	13.0	16.9
1,000	20.8	16.6	16.9	23.0	21.1	15.7	20.5	20.9	14.5	18.3
750	21.4	17.0	17.3	23.2	21.8	16.9	19.5	19.2	15.9	19.3
500	22.3	16.2	18.5	22.5	21.1	16.9	18.3	17.6	17.3	20.2
250	23.0								19.2	21.5
Surface	23.1	16.0	18.9	22.8	20.5	16.8	18.1	17.2	19.4	21.6

637—26——2

TABLE 9.—*Mean temperatures, °C., in various quadrants of well-pronounced "lows" during winter*

Height (m.) M. S. L.	III Q.	IV Q.	I Q.	II Q.	III Q.	IV Q.	Center	II Q.	III Q.	IV Q.	III Q.	IV Q.	I Q.	III Q.	IV Q.
	Broken Arrow, Okla.		Drexel, Nebr.					Ellendale, N. Dak.			Groesbeck, Tex.		Royal Center, Ind.		
4,500	------	------	------	------	------	------	------	------	------	−16.9	------	------	------	------	------
4,000	------	------	−10.5	−11.1	------	−9.9	−14.7	------	------	−14.4	------	------	−13.0	------	------
3,500	−13.4	------	−6.5	−10.3	−13.1	−5.9	−10.2	------	−15.6	−11.3	−8.9	------	−9.3	------	−8.3
3,000	−9.9	------	−8.0	−8.8	−10.3	−2.3	−6.3	−8.9	−11.9	−8.1	−6.3	6.9	−5.3	------	−6.3
2,500	−6.4	3.3	0.3	−6.2	−7.6	0.7	−2.2	−6.4	−8.7	−5.3	−3.7	6.4	−2.2	−10.2	−4.1
2,000	−2.5	7.5	3.3	−4.0	−5.0	3.5	0.2	−4.4	−6.1	−2.0	−1.1	8.3	0.0	−7.3	−1.7
1,500	−0.8	10.5	5.6	−2.0	−3.1	5.7	2.0	−7.0	−4.8	0.8	0.0	10.9	1.9	−5.5	0.4
1,250	−1.1	11.3	5.4	−1.9	−2.6	7.0	2.4	−8.2	−3.9	2.0	0.5	12.2	3.1	−5.4	0.9
1,000	−0.5	11.0	5.7	−3.4	−2.0	7.7	2.3	−8.2	−2.7	1.7	2.0	12.4	4.3	−4.6	1.5
750	−0.7	11.1	3.9	−4.2	−1.3	7.7	3.0	−7.7	−2.8	−0.3	3.9	12.7	4.2	−3.6	1.6
500	1.3	11.3	2.2	−3.4	−1.0	5.2	3.4	−7.4	−2.8	−3.4	5.7	13.5	3.0	−2.0	2.6
250	3.8	11.0	------	------	------	------	------	------	------	------	7.3	14.3	2.1	0.1	3.9
Surface	4.0	11.0	1.7	−2.9	−0.8	3.3	3.7	−7.1	−2.8	−4.0	7.9	14.6	2.0	0.3	4.0

An examination of these tables shows that the seasonal differences in the mean temperatures are greater for HIGHS than for LOWS and greater in the lower levels than in the upper of *both* pressure systems.

The average lapse rates between the ground and 3 km. above sea level in HIGHS and LOWS for summer and winter are shown in Table 10.

TABLE 10.—*Average temperature lapse rates °C. per 100 m., for the air column between the ground and 3,000 m. (sea level) for various quadrants of well-pronounced "highs" and "lows" for summer and winter*

HIGHS

	Summer					Winter				
	1 Q.	2 Q.	3 Q.	4 Q.	Center	1 Q.	2 Q.	3 Q.	4 Q.	Center
Broken Arrow, Okla	------	0.57	0.45	0.31	------	------	------	0.08	0.05	------
Drexel, Nebr	0.34	0.38	0.30	0.42	0.25	------	------	−0.08	0.01	------
Due West, S. C	------	------	------	0.55	------	------	------	0.11	0.30	------
Ellendale, N. Dak	0.52	0.29	0.25	0.38	0.28	------	−0.24	−0.30	−0.01	------
Groesbeck, Tex	------	------	0.47	0.31	------	------	------	0.14	0.08	------
Leesburg, Ga	------	------	------	0.57	------	------	------	------	0.12	------
Royal Center, Ind	------	0.55	0.35	0.41	------	0.17	0.07	0.09	0.17	------
Mount Weather, Va	0.49	0.59	0.55	0.55	------	0.27	0.22	0.05	0.28	------

LOWS

	1 Q.	2 Q.	3 Q.	4 Q.	Center	1 Q.	2 Q.	3 Q.	4 Q.	Center
Broken Arrow, Okla	------	------	------	0.44	------	------	------	0.50	0.43	------
Drexel, Nebr	0.42	------	0.46	0.44	0.43	0.18	0.23	0.36	0.22	0.38
Due West, S. C	------	------	------	------	------	------	------	------	------	------
Ellendale, N. Dak	------	------	0.49	0.35	0.40	------	0.07	0.36	0.16	------
Groesbeck, Tex	------	------	------	------	------	------	------	0.50	0.27	------
Leesburg, Ga	------	------	------	------	------	------	------	------	------	------
Royal Center, Ind	------	------	0.52	0.57	------	0.26	------	0.49	0.37	------
Mount Weather, Va	0.50	0.62	0.61	0.60	------	0.28	0.34	0.53	0.36	------

There have included in this table corresponding values obtained by Blair (*4*) for Mount Weather, Va., which it will be noted are appreciably higher than are those found in the present study. This is partly because the temperature results of the Mount Weather data are based on the *means* of the ascents and descents of kite flights and therefore on higher temperatures, especially for the lower levels, than would have been the case had the ascents only been used as was done for the other stations and partly owing to the fact that the present paper represents primarily the more pronounced pressure types.

Table 10 contains the following significant features:

The average lapse rates to 3 km. are greater in LOWS than in adjacent sectors of HIGHS both for summer and winter, the differences between the two pressure types being most pronounced in winter.

The average lapse rates are greater at the southern stations than at the northern in HIGHS and in LOWS in both seasons.

The average lapse rates are appreciably less in winter than in summer in both HIGHS and LOWS, the seasonal differences being most marked in HIGHS.

The average lapse rates are greater in the front sector of HIGHS than in their rear at the *northern* stations in both seasons, whereas the opposite relationship obtains at the *southern* stations.

The average lapse rates are greater in the rear sector of LOWS than in their front in both seasons at both northern and southern stations.

The pronounced temperature inversions extending to great elevations characteristic of winter HIGHS, especially at the northern stations, are strikingly shown in the average *negative* lapse rates for both their front and rear sectors at Ellendale and in the smallness of the positive values at the other stations.

A comparison was made of the temperature results obtained for Drexel in this study with those found for the same station by Gregg (*5*) in an earlier paper. Although the latter was necessarily based on a shorter record which made it impossible to restrict the pressure types to well pronounced cases, a close agreement was found between the mean temperatures for the upper levels with those found here. However, since the means of the ascents and descents of kite flights were used the values for the surface and lower levels were, as might be expected, generally higher than those found here.

TABLE 11.—*Excess or deficiency (−) of mean temperatures, °C., of (A) the rear sector (second and third quadrants) of "lows" as compared with the front sector (first and fourth quadrants) of "highs" and of (B) the front sector of "lows" as compared with the rear sector of "highs"*

SUMMER

Height (m.) M. S. L.	(A) Northerly currents			(B) Southerly currents			
	Drexel, Nebr.	Ellendale, N. Dak.	Royal Center, Ind.	Broken Arrow, Okla.	Drexel, Nebr.	Ellendale, N. Dak.	Royal Center, Ind.
5,000	------	------	------	------	2.1	------	------
4,500	------	1.7	------	1.4	3.1	------	------
4,000	1.8	4.5	1.7	2.2	3.3	0.9	------
3,500	3.2	4.4	−0.2	2.5	4.3	3.3	−0.1
3,000	3.9	5.0	0.7	2.7	5.4	4.6	0.0
2,500	4.4	5.6	1.6	2.9	6.6	6.3	0.0
2,000	5.0	6.0	2.6	3.5	7.4	8.2	0.3
1,500	4.9	6.3	3.3	3.8	7.6	9.0	1.2
1,250	4.9	6.8	3.7	3.0	7.6	8.9	1.5
1,000	4.5	6.6	4.1	1.8	7.7	7.7	1.7
750	3.7	6.7	4.3	1.3	7.4	6.4	1.6
500	4.5	6.7	4.2	1.4	7.3	6.0	1.8
250	------	------	3.5	1.3	------	------	2.5
Surface	5.1	6.8	3.3	1.3	7.9	6.1	2.5

TABLE 12.—*Excess or deficiency (—) of mean temperatures, °C., of (A) the rear sector (second and third quadrants) of "lows" as compared with the front sector (first and fourth quadrants) of "highs" and of (B) the front sector of "lows" as compared with the rear sector of "highs"*

WINTER

Height (m.) M. S. L.	(A) Northerly currents						(B) Southerly currents					
	Broken Arrow, Okla.	Drexel, Nebr.	Due West, S. C.	Ellendale, N. Dak.	Groesbeck, Tex.	Royal Center, Ind.	Broken Arrow, Okla.	Drexel, Nebr.	Ellendale, N. Dak.	Groesbeck, Tex.	Royal Center, Ind.
4,500									3.6		
4,000		7.3						1.4	2.8		−3.7
3,500		5.4	−3.1	6.8	−5.1			2.8	4.0		−1.2
3,000	−3.7	5.5	−1.6	8.6	−4.1			4.7	3.5	6.1	−0.8
2,500	−2.2	6.3	−0.9	10.6	−2.7	3.7	4.1	6.3	4.3	3.3	0.3
2,000	1.4	7.5	−1.2	12.1	−0.8	6.1	7.0	8.0	6.5	4.1	1.1
1,500	3.7	10.1	−2.4	12.6	0.0	8.2	9.1	10.9	10.5	5.7	2.3
1,250	4.6	11.6	−1.3	13.4	0.3	9.2	9.9	12.3	12.5	6.4	2.7
1,000	6.6	13.0	−0.5	15.0	2.0	9.5	10.2	15.2	13.8	6.3	3.2
750	7.5	13.8	0.2	15.8	4.5	9.6	10.9	16.0	14.2	6.4	4.2
500	8.4	13.3	1.3	15.7	6.9	9.7	11.4	14.3	14.3	7.5	5.8
250	8.4		2.8		7.8	9.9	10.7			9.0	7.1
Surface	8.4	13.0	2.6	15.7	7.9	9.9	10.6	13.1	14.4	9.8	7.3

Considering sections (A) and (B) of Tables 11 and 12 as representing, in general, northerly and southerly winds, respectively, it is evident that in summer, LOWS average *warmer* than the adjacent sectors of HIGHS. The differences become progressively smaller, however, from northern to southern stations and from lower to higher altitudes.

In winter, at the *northern* stations, LOWS likewise average *warmer* than HIGHS, but at the *southern* and *eastern* stations they average *colder* in the *upper* levels, particularly in their rear sector as compared with the front sector of HIGHS.

European observations have shown that LOWS there average colder, above the lowest levels, than do HIGHS. In regard to this, J. Bjerknes and H. Solberg (*8*) state:

> A very large percentage of European cyclones are occluded ones, being dying remainders of previously strong Atlantic depressions. The predominance of occluded cyclones in Europe has led to the statistical result that cyclones usually have a cold core. A special investigation of the relatively infrequent young deepening cyclones will certainly afford evidence of their assymetric thermal structure.

In the United States, especially in the more western parts, most cyclones *are* "young deepening cyclones" and the results in this paper evidently substantiate the final statement of the above quotation.

W. R. Gregg (*5*) in discussing the results he obtained for Drexel as contrasted to those for Europe, states:

> The climate of western Europe is essentially marine in character. As such, its temperatures are subject to relatively small fluctuations due to the importation of air from adjacent localities under the influence of winds having successively a northerly and a southerly component. The proximity of the Gulf Stream tends further to a spreading out of the latitudinal isotherms, thus adding to the moderating influences of the ocean. The result is that the effects of radiation, pressure and vertical circulation are so much greater than those due to northerly or southerly winds as to produce what are actually observed, viz, lower temperatures in cyclones than in anticyclones.
>
> The United States, on the other hand, i. e., those portions in which observations have been made, has a typically continental climate, and its temperatures are alternately affected by strong winds from a very cold northerly region and by almost equally strong winds from a very warm region. The fluctuations are large, so large indeed that they tend to mask the effects of the other factors already referred to. That these latter are operating, however, is perhaps indicated by the fact that there is less difference in the temperatures at the upper levels than at the earth's surface; more particularly is this true at Mount Weather, which lies to the south of most pronounced antcyclonic and cyclonic activity; moreover, its proximity to the Atlantic gives it to some extent a marine climate, so far as easterly and southerly winds are concerned.
>
> Another probable contributing cause to the temperature difference in the two continents is the fact that pressure systems in Europe move only about two-thirds as rapidly as do those in the United States. In Europe, therefore, the heating and cooling effects of radiation, vertical circulation, etc., are more pronounced, since they have greater opportunity for development.

It would seem that the above explanation regarding anticyclones and that given by Bjerknes and Solberg for the "cold" cyclones found in Europe are well substantiated by the results shown in this paper.

W. Peppler (*6*) using the same observational data as that used by A. Peppler (see p. 201) has compiled the average temperature lapse rates (not actual temperatures) for 500 m. intervals for various quadrants of HIGHS and LOWS. A comparison of his results with those given in this paper showed, as in the case of the Mount Weather data, certain differences which are obviously due to the inclusion of the less pronounced pressure areas in the German study. This resulted in the latter showing wide variations in the mean vertical temperature gradients for the individual years to which fact the author frequently calls attention. Moreover, part of the differences between the two sets of data were doubtless due to the different plans followed in the methods of classifying, reference to which was previously made. Strata of maximum and minimum average lapse rates found for all quadrants of HIGHS and LOWS for each season were pointed out and in most cases the author inferred a connection between them and layers of minimum and maximum cloudiness, respectively. Too much significance, however, seems to the present writer to have been attached to exceedingly small variations in the average lapse rates obtained.

However, notwithstanding the differences in the plans followed in the two studies, it was found that in general the fundamental characteristics of the average temperature lapse rates of HIGHS and LOWS as regards distinctions for quadrants and seasons were substantially the same for both countries.

RELATIVE HUMIDITY

The mean relative humidities for various quadrants of HIGHS and LOWS for summer and winter are shown in Figures 30 to 33, inclusive.

The relatively early morning hour at which these flights were begun is responsible for the comparatively high mean relative humidities indicated for the surface, especially at the northern stations. Flights made a few hours later in the day would have resulted in the curves being practically vertical, from the ground to about 3 km.

The mean relative humidities in both HIGHS and LOWS at the *northern* stations are somewhat greater in winter than in summer. The differences become negligible, however, at the upper levels. At the *southern* stations this relationship, in the case of HIGHS, is opposite, viz, the relative humidity averages highest in summer. Insufficient observations at the southern stations prevent this seasonal comparison for LOWS. It has been shown by Gregg (*7*) that the seasonal relationship between the mean surface relative humidities at the northern and southern stations (determined *without* respect to prevailing pressure distribution) was the same as found here, viz, the relative

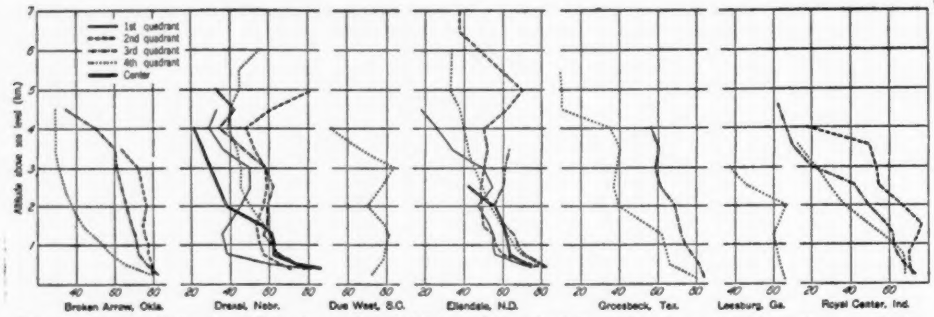


FIG. 30.—Mean relative humidities for various heights as determined from kite observations in various quadrants of well-pronounced HIGHS during summer

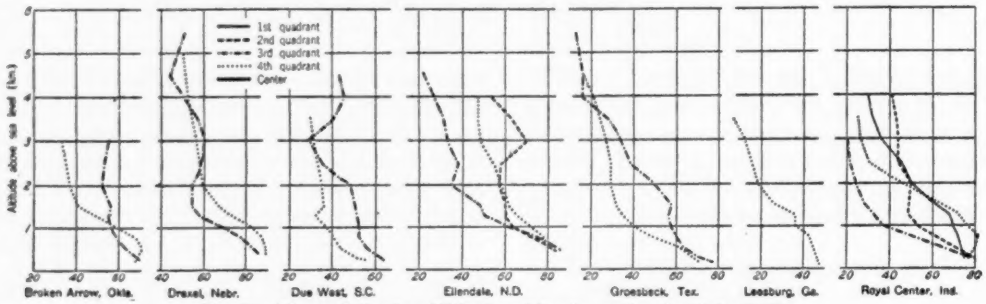


FIG. 31.—Mean relative humidities from kite observations in winter HIGHS

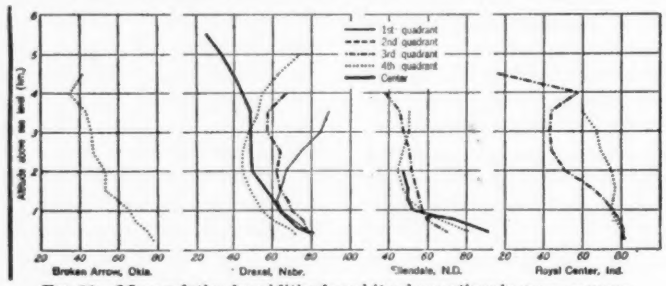


FIG. 32.—Mean relative humidities from kite observations in summer LOWS

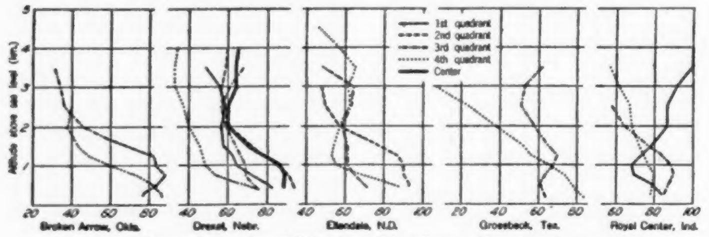


FIG. 33.—Mean relative humidities from kite observations in winter LOWS

humidity averages highest in summer at the *southern* stations and highest in winter at the *northern* stations.

A prominent feature noted in the graphs for winter HIGHS (fig. 31) is the relationship between the mean values for the third and fourth quadrants. It is evident that at Ellendale, Drexel, and Royal Center, the three northern stations, the mean relative humidity, both in the lower and upper levels averages higher in the fourth quadrant than in the third, whereas the opposite relationship occurs at the southern stations. This is, in all probability, due to the southerly winds of comparatively heavy moisture content blowing over the latter stations.

The mean relative humidity in the upper levels of the rear sector of HIGHS in summer is greater, in general, than that for their front sector, the differences being larger at the southern stations that at the northern.

The central region and fourth quadrant of HIGHS contain comparatively *low* relative humidity in their *upper* levels. From the data available it is found that the highest relative humidities in the upper levels of HIGHS occur in their second quadrant in both seasons.

TABLE 13.—*Excess or deficiency (−) of mean relative humidities (per cent) of (A) the rear sector (second and third quadrants) of "lows" as compared with the front sector (first and fourth quadrants) of "highs" and of (B) the front sector of "lows" as compared with the rear sector of "highs"*

SUMMER

Height (m.), M. S. L.	(A) Northerly currents			(B) Southerly currents			
	Drexel, Nebr.	Ellendale, N. Dak.	Royal Center, Ind.	Broken Arrow, Okla.	Drexel, Nebr.	Ellendale, N. Dak.	Royal Center, Ind.
5,000					22		
4,500		26		5	17		
4,000	29	1		−17	20	15	
3,500	13	3	44	−19	11	−6	25
3,000	9	−2	24	−18	−3	−3	29
2,500	14	−4	12	−19	−10	−3	25
2,000	12	−3	11	−15	−9	−5	21
1,500	9	−4	15	−13	−4	−6	13
1,250	7	−5	15	−11	−1	−9	10
1,000	11	−5	14	−6	−1	−4	10
750	16	−4	13	−5	1	1	11
500	8	−7	14	−2	1	1	12
250			14	−4			10
Surface	3	−8	14	−4	−2	1	9

TABLE 14.—*Excess or deficiency (—) of mean relative humidities (per cent) of (A) the rear sector (second and third quadrants) of "lows" as compared with the front sector (first and fourth quadrants) of "highs" and of (B) the front sector of "lows" as compared with the rear sector of "highs"*

WINTER

Height (m.), M. S. L.	(A) Northerly currents						(B) Southerly currents				
	Broken Arrow, Okla.	Drexel, Nebr.	Due West, S. C.	Ellendale, N. Dak.	Groesbeck, Tex.	Royal Center, Ind.	Broken Arrow, Okla.	Drexel, Nebr.	Ellendale, N. Dak.	Groesbeck, Tex.	Royal Center, Ind.
4,500									14		
4,000		16						−5	19		50
3,500		13	26	4	38			−12	21		42
3,000	10	6	22	18	26			−14	14	−27	39
2,500	10	3	21	12	22	28	−13	−10	18	−14	40
2,000	18	2	26	3	29	22	−14	−7	16	−12	36
1,500	37	1	36	6	33	17	−13	−4	5	−6	35
1,250	27	−2	39	3	35	16	−6	−5	3	−1	34
1,000	27	−6	35	−2	28	17	5	−13	−3	8	31
750	23	−8	32	−5	15	15	15	−15	−4	14	22
500	17	−7	34	−3	0	13	18	−9	2	15	13
250	14		26		−5	10	17			10	2
Surface	14	−5	23	−3	−7	10	17	−7	4	7	0

From Tables 13 and 14 it is evident that for both summer and winter the differences between the mean relative humidities of HIGHS and LOWS at Drexel and Ellendale, the northernmost stations, are almost inappreciable but indicate for the most part a slightly greater mean relative humidity in HIGHS than in LOWS at these stations.

In winter, at the southern and eastern stations, the mean relative himidity is appreciably greater in LOWS than in HIGHS. This comparison has not been found possible for the southern stations for summer owing to insufficient observations.

VAPOR PRESSURE

The mean vapor pressures for various quadrants of HIGH and LOWS for summer and winter are shown in Figures 34 to 37, inclusive.

A striking agreement will be noted in the relative order of the curves for the various quadrants as compared with the temperature curves for corresponding quadrants. This is to be expected from the well-known relationship between the absolute humidity and temperature.

It is evident that the mean vapor pressures for both HIGHS and LOWS are appreciably greater at the southern than at the northern stations, with the differences dimishing with altitude and practically disappearing above 5 km. This latitudinal relationship in the mean vapor pressures of HIGHS and LOWS is considerably less marked, however, for LOWS than for HIGHS, particularly in the lowest levels. It is decidedly greater in summer than in winter, especially for HIGHS. The marked latitudinal variation occurring in summer instead of winter stands in opposite relationship to that found for temperature. This fact, however, is readily explained by the considerably greater difference in the capacity of air for moisture within a given range of relatively high temperatures as compared with that for the same range at lower temperatures.

The seasonal variation in the mean vapor pressures for both HIGHS and LOWS is appreciable, being somewhat greater, however, for the former than the latter.

It is evident that the range in the mean vapor pressures between the lowest and highest levels is considerably greater in LOWS than in HIGHS.

TABLE 15.—*Excess or deficiency (—) of mean vapor pressures, mb., of (A) the rear sector (second and third quadrants) of "lows" as compared with the front sector (first and fourth quadrants) of "highs" and of (B) the front sector of "lows" as compared with the rear sector of "highs"*

SUMMER

Height (m.) M. S. L.	(A) Northerly currents			(B) Southerly currents			
	Drexel, Nebr.	Ellendale, N. Dak.	Royal Center, Ind.	Broken Arrow, Okla.	Drexel, Nebr.	Ellendale, N. Dak.	Royal Center, Ind.
5,000					0.63		
4,500		0.99		0.05	1.11		
4,000	2.83	0.74		−1.03	1.82	1.66	
3,500	2.52	1.45		−1.32	1.81	0.86	2.59
3,000	2.52	1.45	2.45	−1.09	1.28	1.53	3.31
2,500	3.38	1.84	1.69	−0.89	1.14	1.85	3.35
2,000	3.81	2.52	2.23	−0.70	1.95	2.23	3.14
1,500	4.33	3.06	3.98	−0.80	3.31	3.15	2.61
1,250	4.11	3.26	4.42	−0.04	4.19	3.00	2.56
1,000	4.82	3.54	4.89	0.08	4.62	3.84	2.99
750	5.58	3.87	5.32	0.25	5.29	4.61	3.65
500	5.14	4.19	5.83	1.03	6.20	5.05	4.37
250			6.23	0.61			5.11
Surface	4.89	4.02	6.10	0.64	6.54	5.26	5.16

TABLE 16.—*Excess or deficiency (—) of mean vapor pressure, mb., of (A) the rear sector (second and third quadrants) of "lows" as compared with the front sector (first and fourth quadrants) of "highs" and of (B) the front sector of "lows" as compared with the rear sector of "highs"*

WINTER

Height (m.) M. S. L.	(A) Northerly currents						(B) Southerly currents				
	Broken Arrow, Okla.	Drexel, Nebr.	Due West, S. C.	Ellendale, N. Dak.	Groesbeck, Tex.	Royal Center, Ind.	Broken Arrow, Okla.	Drexel, Nebr.	Ellendale, N. Dak.	Groesbeck, Tex.	Royal Center, Ind.
4,500									0.93		
4,000		0.98						0.25	0.94		1.01
3,500		0.87	−0.46	0.52	0.50			−0.07	0.85		1.47
3,000	−1.27	0.73	−0.16	1.00	0.46			0.05	0.69	0.02	1.71
2,500	−0.74	0.70	0.40	1.26	0.77	1.25	−1.99	0.45	0.98	0.58	2.11
2,000	0.44	0.99	1.10	1.39	1.45	1.61	−1.82	0.96	1.39	0.73	2.25
1,500	2.44	1.74	1.70	1.74	2.01	2.18	1.70	1.78	1.73	2.11	2.73
1,250	2.87	2.03	2.38	1.83	2.23	2.53	2.69	2.13	2.00	3.17	2.88
1,000	2.94	2.23	2.55	1.99	2.33	2.58	4.33	2.66	2.13	4.71	3.08
750	3.24	2.45	2.81	2.19	2.37	2.53	6.08	3.23	2.55	5.84	2.86
500	3.46	2.67	3.50	2.36	2.11	2.67	6.81	3.55	2.93	6.90	2.78
250	3.51		3.56		2.17	3.02	6.76			7.23	2.65
Surface	3.53	2.79	3.49	2.41	2.23	3.05	6.75	3.38	2.91	7.54	2.62

It is evident from Tables 15 and 16 that the mean vapor pressures are appreciably greater in LOWS than in HIGHS, with the greatest differences occurring in winter in those sectors represented by section (B). Broken Arrow and Groesbeck, the southern stations, show the maximum differences in this respect.

SUMMARY

In general the results of this paper are in substantial agreement with those obtained by Blair (4) for Mount Weather, Va. Certain differences are to be expected, however, since Blair used the means of the ascents and

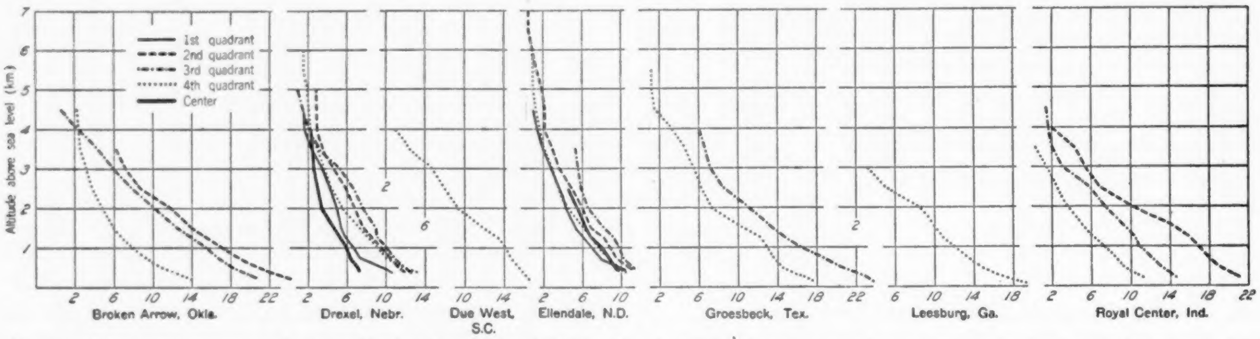


FIG. 34.—Mean vapor pressures, mb., for various heights as determined from kite observations in various quadrants of well-pronounced HIGHS during summer.

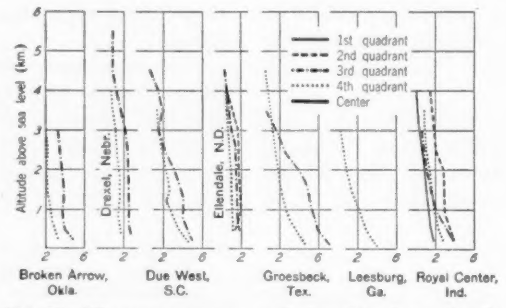


FIG. 35.—Mean vapor pressures, mb., from kite observations in winter HIGHS

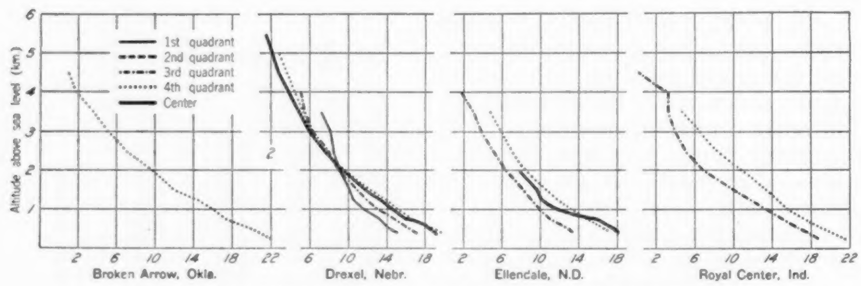


FIG. 36.—Mean vapor pressures, mb., from kite observations in summer LOWS

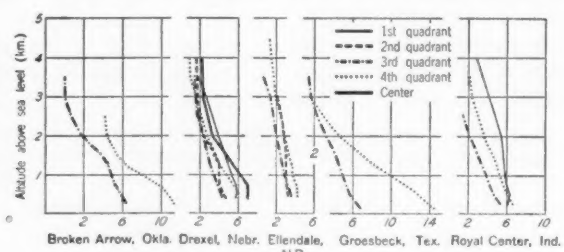


FIG. 37.—Mean vapor pressures, mb., from kite observations in winter LOWS

The negative values indicated for Broken Arrow for summer under section (B) of Table 15 may reasonably be attributed to an insufficient number of observations since both the southern stations, Groesbeck and Leesburg, while not represented in the tables, are found to agree with the northern stations in that the vapor pressures in both seasons average greater in LOWS than in adjacent sectors of HIGHS.

descents while in the present paper only the ascents are represented. Furthermore, the results shown here represent primarily the more pronounced pressure types.

The following results may be emphasized:

1. The characteristics distinguishing HIGHS from LOWS are most pronounced in their lower levels.

2. The front sector of HIGHS should not be considered as synonymous with the rear sector of LOWS nor should the

rear sector of HIGHS be so considered with respect to the front sector of LOWS, since the mean values of the various elements in these respective regions show distinct differences, which, however, decrease with elevation until they become inappreciable above 5 km.

3. Mean wind velocities for adjacent sectors of HIGHS and LOWS are greater in the latter than in the former for the same levels and seasons.

4. Mean wind velocities in HIGHS, i. e., above the gradient wind level (approximately 500 m. above ground), are greatest in their first and fourth quadrants (front sector) and least in their second and third (rear sector), whereas in LOWS they are greatest in the third and fourth quadrants and least in the first and second.

5. There is usually a rather abrupt retardation in the rate of increase of wind with elevation or in some cases even a falling off in velocity beginning at about 500 m. above ground and ending at from 1 to 2 km. This condition is considerably more pronounced in the second and third quadrants of HIGHS than in their first and fourth, whereas in LOWS it is most marked in the first and second quadrants and least in the third and fourth.

6. The mean winds are very light in the *lower* levels of the central region of HIGHS, being lighter than in any of the four quadrants. In the *upper* levels of this region, however, they increase considerably and conform closely to the mean values of the first and fourth quadrants, i. e., the region of HIGHS containing the strongest winds aloft.

7. The mean winds are relatively strong in the *lower* levels of the central region of LOWS as compared to the corresponding region of HIGHS, but in the *upper* levels they are relatively light as compared with the quadrants of LOWS containing the strongest winds, viz, the third and fourth.

8. The second and third quadrants of HIGHS contain a considerably greater change in the mean wind direction with elevation than do their first and fourth, whereas in LOWS this change is greatest in the first and second quadrants and least in the third and fourth.

9. A common mean wind direction for all quadrants of HIGHS is reached at a greater height in summer than in winter and at successively higher altitudes from northern to southern stations.

10. The average temperature lapse rate in both the front and rear sectors of HIGHS and LOWS is greater in summer than in winter, the seasonal differences being considerably greater for HIGHS than for LOWS.

11. The average lapse rate is greater in LOWS than in the adjacent sectors of HIGHS for the same season, the differences being appreciably greater in winter than in summer.

12. In summer, LOWS average *warmer* than the adjacent sectors of HIGHS, the differences becoming progressively smaller from northern to southern stations and from lower to higher altitudes.

In winter, LOWS average *warmer* than HIGHS at the northern stations but generally *colder* at the *southern* and *eastern* stations, in their *upper* levels, particularly in their rear sector as compared with the front sector of HIGHS.

13. The front sector of HIGHS in winter averages colder than the rear to at least 5 km., the differences *decreasing* from northern to southern stations. For the same season the front sector of LOWS averages warmer than the rear to at least 4 km., however, in this case the differences *increase* from northern to southern stations.

14. The differences between the mean relative humidities for adjacent sectors of HIGHS and LOWS at *northern* stations are almost inappreciable, but slightly *lower* humidities are indicated, in general, for LOWS than for HIGHS in both seasons. The opposite relationship is found, however, at the *southern* and *eastern* stations in winter, where the relative humidities average *higher* in LOWS than in HIGHS.

15. The relative humidity in HIGHS and in LOWS at the *northern* stations averages a little higher in winter than in summer, whereas the opposite relationship occurs in the case of HIGHS at the southern stations.

16. The relative humidity in the *upper* levels of HIGHS averages highest in the second quadrant and lowest in the central region. In general, at all levels, it averages higher in the fourth quadrant of HIGHS than in the third, at the northern stations but the opposite relationship occurs at the southern stations.

17. The mean vapor pressures in both seasons are appreciably greater in LOWS than at the same levels of the adjacent sector of HIGHS.

18. The mean vapor pressures in HIGHS and in LOWS are greater at the southern stations than at the northern for the same seasons and levels. This latitudinal variation is appreciably less for LOWS than for HIGHS in both seasons.

19. The mean vapor pressures of the front sector of HIGHS average lower than those of their rear sector both at the northern and southern stations in both seasons, whereas in LOWS the mean values are, in general, lowest in the rear sector. These differences, in both pressure systems, diminish with altitude.

20. It was found, in general, that the fundamental characteristics as shown by the mean values for the various quadrants of HIGH and LOWS, as herein found, are in substantial agreement with the results of other investigators in this country and in Germany.

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NOTES, ABSTRACTS, AND REVIEWS

SOLAR AND TERRESTRIAL RELATIONSHIPS

The first Report of the Commission appointed by the International Research Council to further the study of solar and terrestrial relationships has been received. English and French texts are each printed in full. The body of the report consists of memoranda which form an invaluable summary of the present state of knowledge of the subject and of the outlook for further research. We reprint here a part of the introductory section and three memoranda touching solar relationships with terrestrial weather.

(5) On reviewing present knowledge of the phenomena which the committee are charged to study, they conclude that the principal terrestrial phenomena which are definitely known to be affected by intrinsic changes in the state of the sun, or by changes in the presentation of the sun toward the earth (owing to the solar rotation), are as follows:

(*a*) The magnetic state of the earth and earth currents.
(*b*) Aurorae.
(*c*) Meteorological and climatic changes.

They conclude also that the following phenomena are not improbably affected by the aforesaid solar changes, but that there is need for further series of observations in order that the matter may be thoroughly investigated.

(*d*) Atmospheric electricity (potential gradient and general ionization of the atmosphere).
(*e*) Radio-telegraphic transmission.

They conclude further that the following phenomena are sufficiently likely to be affected by such solar changes to require further investigation from this standpoint:

(*f*) The amount of ozone in the upper air.
(*g*) The extra-polar auroral light.
(*h*) High-level atmospheric absorption.
(*i*) Penetrating radiation in the atmosphere.
(*j*) The light of the night sky.

(6) The committee consider that the principle variable solar phenomena which can be definitely asserted to affect terrestrial conditions are as follows:

(*k*) The general radiation of the sun.
(*l*) Local disturbance on the sun, as manifested by sunspots, faculae, and prominences.
(*m*) The general march of the solar cycle.

They conclude also that the following solar phenomenon probably affects terrestrial conditions, but that this has not yet been established:

(*n*) Solar disturbance manifested by intense local magnetic fields, but without visible markings.

They conclude further that the following solar phenomena are sufficiently likely to affect terrestrial conditions to warrant further investigation from this standpoint:

(*o*) The alternation of the magnetic polarity of sunspots in successive eleven-year cycles.
(*p*) Absorbing matter ejected from the sun, such as is indicated by photographs of the corona and of prominences.

Notes on the Relationship of Solar and Terrestrial Phenomena

By C. G. ABBOT

1. THE VARIATION OF SOLAR RADIATION

It seems to be well established that the sun's output of radiation is variable. The variations appear to be irregular in time and amount. They are associated, apparently, with changes in the sun's visible features. Numerous sunspots and great activity accompany a high level of the solar constant, and vice versa. But the passage of a spot or group of spots across the central solar meridian near the equator is almost invariably followed, the next day, by a minimum of the solar constant. From a comparison of Smithsonian solar work with too few determinations of Saturn's brightness, by Guthnick, it appears probable that this effect of central passage of sun-spots means that rays of diminished transparency emanate nearly radially from the sun and rotate with its rotation. Consequently, the effects pass rapidly along and reach one planet after another in order of their heliocentric longitudes. Further investigations of the brightness of the planets ought to be made to test this hypothesis.

The magnitude of solar changes seldom exceeds 5 per cent, but the total range of fairly weighty solar constant values thus far observed exceeds 10 per cent.

The investigation of solar variation is difficult and costly. The Smithsonian Institution is not assured of funds to maintain it after July, 1925. The sources of error are so insidious that long experience is almost indispensable. It is greatly to be hoped that financial means will be found to continue the two Smithsonian stations, now in operation, without a break in their records for many years.

2. INFLUENCE OF SOLAR VARIATION ON METEOROLOGY

Mr. H. H. Clayton has given by far the most study to this question. His published results in his book, World Weather, are notable, but his unpublished results, which I have had the opportunity to see, are even more notable. Hardly anything except the continuance of the two Smithsonian stations, I believe, would be better worth while than to give Mr. Clayton an adequate number of computers, and the assistance of one or or two young men of good parts and training, so that he might devote the years remaining to him effectively to this investigation and leave trained disciples to continue it.

Referring to Figure 193, page 231, of Clayton's World Weather, it is to be noted that the solar changes found by Smithsonian observers in Chile were very closely parallelled, without appreciable lag in time, in the barometric pressure at Sarmiento, Argentina. They may have been a few hours' lag of the barometric curve, but certainly much less than one day. How can this correlation, in the sense high solar constant, high barometric pressure, be explained? It is not reasonable to suppose the sun's variation acts directly on the barometric pressure. It must act indirectly through the temperature. As the atmosphere absorbs a large proportion of the solar rays, from 15 per cent up, according to conditions, and as the atmosphere has but small capacity for heat, its temperature response to solar changes must be almost immediate. In this respect, we must note a distinction between the atmosphere as a whole and the layer close to the ground which is influenced to a considerable extent by slowly changing ground temperatures.

The direct influence of increase of solar radiation being to warm the atmosphere, it would tend to expand it. Thus, air would flow from regions of high atmospheric absorption to those of lower. Since barometric pressure at Sarmiento appears to increase with increasing solar constant, the inference would be that this station, which lies in an arid region about 60 miles from the Atlantic Ocean, has a clearer, less absorbing atmosphere than its surroundings. There would be great interest in tracing such conditions in other regions, with a view to establishing real relations between solar variations and terrestrial conditions.

Memorandum on the Study of Solar Radiation and Meteorology

By G. C. SIMPSON

As all movement in the atmosphere depends ultimately on energy received from the sun mainly in the form of solar radiation, it goes without saying that the meteorologist is vitally interested in variations, periodic and secular, in the sun's radiation.

Investigators up to the present have used two methods of attack on the problem of the relationship between the sun and the weather. In the first, sunspots have been taken to be an indication of solar activity and variations in terrestrial weather corresponding with variations in sunspots have been sought. The 11-year solar period has played the predominating part in all such investigations. The second method has made use of the data made available by the work of Abbot and his coworkers. Abbot's measurements have made it possible to follow from day to day the changes in the solar radiation received on the confines of our atmosphere, and several investigators, chief amongst them being Clayton, have attempted to correlate these with meteorological factors.

Speaking broadly, one must say that the results up to the present have been disappointing. Clear and definite relationships have not been found between sunspots and weather similar to those which have been found in the case of terrestrial magnetism. The 11-year period is certainly recognizable in some meteorological factors, but in very few cases is the amplitude of any practical importance. The investigations into the day-to-day variations of solar radiation have been little more successful, although Mr. Clayton has exhibited many interesting and suggestive curves.

It is practically impossible to work out a priori what effect an increase in solar activity would have on the weather of any given

place. It is generally admitted that temperature would rise in some areas and fall in others, and even this varies with the season. The general circulation of the atmosphere would no doubt be intensified, but what changes in the distribution of pressure and rainfall this would involve can not be stated. It is also not certain that an increase in solar radiation results in more radiation reaching the earth's surface, for the upper atmosphere may at the same time become more opaque to solar radiation.

All these problems require investigation but nothing can be done without absolutely reliable information about the solar radiation. There are plenty of meteorological data for most problems, it is the solar data which are lacking.

In order to obtain the information required, there should be more stations in different parts of the world repeating the work done at Washington, Mount Wilson (Calif.), Montezuma (Chile), and Harqua Hala (Ariz.), so that errors due to the earth's atmosphere may be detected and eliminated. This would give satisfactory information regarding the energy received on the confines of the atmosphere. We need, in addition, measurements of the radiation received at the earth's surface. This is a much more difficult problem. Instruments and methods are available, but the practical difficulties of making the measurements and interpreting the results are very serious. So far as I know, there does not exist at present a single series of measurements from which it is possible to determine the periodic and secular variations, over any extended period, of the solar energy received at the earth's surface.

With regard to the former—the measurement of the solar radiation outside the atmosphere—the work requires a special observatory with expensive instruments and specialized staff. It is, therefore, primarily work to be undertaken by governments. In the present financial state of the world it will be difficult, but probably not impossible, to get governments to undertake the expense; the committee might do something in this direction.

The measurement of the radiation received at the earth's surface is not such an expensive matter. What is required is an agreemenl on the instruments and methods which will give the best results and provision made for the comparison of different instruments. Then instruments must be installed where they will be kept in constant and careful use, so that homogeneous series of data may, in the course of a few years, be available for statistical investigations.

Solar Relations with Weather

By Sir GILBERT T. WALKER

Apart from the effects of variations in the solar constant from day to day upon meteorological conditions, upon which H. H. Clayton is working, there are relationships between monthy and seasonal data of the solar constant or sunspot numbers on the one hand and of rainfall, pressure, or temperature on the other; thus the correlation coefficient between sunspots and the annual temperature of India, as given by the data of 47 years, is as high as -0.5. These relationships strongly suggest that at times of increased solar activity there is increased opacity to heat radiation both within the earth's atmosphere and outside it in regions where the ordinary extrapolation is ineffective; such questions clearly deserve study.

An extension of determinations of the solar constant to new countries is highly desirable; and it would be of great value if an independent method, such as that of photometry, could be applied. The measures of Jupiter's brightness from 1878 to 1890 by Müller, of Potsdam, were promising, as was the suggestion by Evershed of studying the brightness of the moon.

LATE ICE IN LAKE ERIE

Mr. J. H. Spencer, of the Buffalo Weather Bureau Office, has sent us information on the extraordinary ice conditions in Lake Erie before and during the very late opening of navigation this year. The following notes and excerpts are of interest:

At the end of April ice fields approximately 35 miles long occupied the eastern end of the lake except for small patches of open water along the Canadian side. The first attempt to break through the ice was made on April 30 by three freighters, which got only 5 miles out of Buffalo before being stuck fast for a week. On May 6, 18 ships attempted the passage and on the 7th 18 more, and on the following days yet more.

It was not until May 9, at 1:25 p. m., that navigation was finally opened by the arrival of the freighter *W. A. Reiss* from Chicago, followed by 13 others, which laboriously had broken their way through the heavy ice fields. Ten of the west-bound fleet of 55 vessels reached open water on May 10.

The almost unprecedented coldness of this spring was responsible for this historic battle with the ice. The mean temperature for March was 4.3° F. below normal, and for April 7.8° F. below. April's monthly mean temperature of 35.0° F. was the lowest for this month at Buffalo since 1874; hence the ice did not disintegrate in April as usual. Moreover, strong NE. winds were almost absent in April and May, and consequently were of no help in breaking up the ice in the eastern end of the lake.

This note appears in our Daily Local Record of May 26: "There are still great fields of soft ice in this end of Lake Erie. Inbound and outbound vessels plow through it with great difficulty. Accidents are frequent, and numerous vessels have been damaged by ice, the damage being confined chiefly to wheels and rudders."

"There were great quantities of ice in the lake on May 31. * * * On June 1, however, it had almost disappeared as though by magic. After two postponements, the lake passenger season between Detroit and Buffalo was opened on June 2 * * *. These unprecedented conditions caused great money loss to the port of Buffalo and to the commerce of the Great Lakes, due in part to the damage of vessels, but chiefly to the late opening of navigation."

WEATHER BUREAU STAFF MEETINGS, 1925–26

By EDGAR W. WOOLARD, Secretary

The regular biweekly meetings of the scientific and technical staff of the Central Office of the United States Weather Bureau, initiated in the autumn of 1923, have been continued on the same plan as heretofore, during the winter of 1925–26. Following is a list of the discussions (asterisks denote speakers from outside the Weather Bureau); meetings during previous seasons have been reported in the MONTHLY WEATHER REVIEW, 1924, **52,** 35–36, 166, and 1925, **53,** 264.

September 30, 1925

W. J. Humphreys. Report on proceedings of the Babson conference on long-range weather forecasting.

October 7, 1925

A. J. Henry. Monthly pressure variations in the northern hemisphere, and their bearing on seasonal weather forecasting.

C. L. Mitchell. The accuracy of forecasts made from variations in solar radiation.

October 21, 1925

Discussion of G. C. Simpson's paper on "The New Ideas in Meteorology."

November 4, 1925

**G. Breit.* The Kennelly-Heaviside layer.

November 18, 1925

**H. U. Sverdrup.* Meteorological observations off the coast of Siberia during the *Maud* expedition.

December 2, 1925

W. R. Gregg. Atmospheric discontinuities, permanent and temporary.

December 16, 1925

A. J. Henry. The North Pacific statistical anticyclone.

January 13, 1926

O. L. Fassig.—Rainfall of the Caribbean region.

January 27, 1926

O. L. Fassig. Upper air work at San Juan.
C. F. Marvin. A proposed international temperature scale.

February 10, 1926

C. F. Marvin. Recently published investigations of meteorological periodicities.

February 24, 1926

Messrs. Weightman, Mitchell, and *Henry.* Analysis and discussion of Clayton's weather forecasts from solar radiation data.

March 10, 1926

**C. F. Brooks.* The Gulf Stream and the Weather: Project and Progress.

March 24, 1926

H. H. Kimball. Possible thermal effects of fluctuations in the solar constant, of fluctuations in insolation, and of fluctuations in ultraviolet solar radiation.
W. J. Humphreys. Measurements of ultraviolet solar radiation, and of ozone in the atmosphere.

April 7, 1926

H. C. Frankenfield. The Weather Bureau's river work in the Ohio Valley.

April 21, 1926

**C. G. Rossby.* The work of the Swedish meteorological service.

May 5, 1926

**Capt. A. H. Thiessen.* The meteorological work of the United States Signal Corps.

May 13, 1926

**C. F. Brooks.* The general problem of scientific long-range forecasting.

May 19, 1926

C. F. Marvin and *E. B. Calvert.* The Weather Bureau Service on the Pacific coast, with especial reference to fire-weather warnings.

HAILSTORM AT DALLAS, TEX., MAY 8, 1926

By JOSEPH L. CLINE

[Weather Bureau Office, Dallas, May 10, 1926

On the morning of May 8, 1926, the northern portion of eastern Texas was in the southeast quadrant of a fairly well marked depression with a trough formation extending northward from the lower Rio Grande Valley. A warning of local thunderstorms was issued at Dallas on this morning.

The sky on the 8th was generally clear to partly cloudy, and the temperature rose from 65° F., at 4 a. m. to 85° at 5 p. m. The sun shone brightly in the afternoon, with no local indications of any disturbance except a slowly falling barometer, until 4:10 p. m., when a heavy bank of clouds came from the north and northwest, covering the sky by 4:40 p. m. Rain began at 6:59 p. m., and hail fell with the rain from 7:04 p. m. to 7:25 p. m., the barometer having reached its lowest point, 29.59 inches, at about 7:10 p. m., after which a sharp rise of 0.08 inch occurred. Vivid lightning attended the storm, but there were no unusual meteorological conditions except the unprecedented hailstorm. The storm moved toward the southeast, its center passing slightly east of the station.

Hail fell over an area 1 to 15 miles wide, from about 25 miles north of Dallas to more than 25 miles southeast of Dallas, the region of heaviest hail and greatest damage extending from about 10 miles north of the city southward over the central and eastern portions of it to about 15 miles southeast of the Weather Bureau station. No rain or hail fell 10 miles southwest of the station and none in the southwest portion of Oak Cliff.

Hailstones of various sizes and shapes were reported. Some were compared in size to hen's eggs and others to baseballs, while on the outer edge of the storm they were as small or smaller than common moth balls. Near White Rock Lake some of them measured 7 inches in circumference the long way and 5 inches round the body. Hailstones which fell in Highland Park, 5 miles north of the Weather Bureau station, measured 2 to 4 inches in diameter, some being as large as and having the shape of good-sized cooking squash. Reliable reports indicate that the largest hailstones were 8 to 12 inches in circumference, having 5 to 8 layers, some of the stones weighing 22 ounces. Mr. P. S. Cook, observer, who was in the storm near the Weather Bureau office, measured one hailstone 4.2 inches in diameter.

Damage by hail and wind to structures in Dallas and Dallas County was estimated at more than three-quarters of a million dollars. In buildings in the business section of the city plate-glass windows, glass in windows on northern exposures and in most skylights were broken. Many residences will have to be supplied with new roof coverings, especially in the southeastern part of the city, where roofs of composition, tile, and old shingles were demolished. Tops of automobiles and street cars were punctured by the hailstones. The damage at its worst was so great that the scene in the streets resembled destruction by machine-gun fire.

Scores of people were injured, none fatally. A few horses and other animals were reported to have been killed. Crops and much fruit were destroyed, though the area of total loss of these was small. The sunshine recorder was the only instrument broken by hail at the Weather Bureau office.

METEOROLOGICAL SUMMARY FOR SOUTHERN SOUTH AMERICA, APRIL, 1926

By Señor J. B. NAVARRETE

[El Salto Observatory, Santiago, Chile]

(Translated by B. M. V.)

The atmospheric régime over Chile during April was relatively stable, and it was somewhat rainy in the southern zone.

High pressure in the south during the 2d–4th caused generally fine weather in southern South America.

Between the 5th and 7th an important depression crossed the far southern region, causing rain over the southern part of the continent as far north as Arauco Province. At Valdivia 15 mm. fell on the 6th.

During the 8th–14th high pressure occupied the southern area, causing generally fine weather and low temperature, with cold waves in the southern Provinces and minima below freezing in Lonquimay.

On the 15th a new depression crossed the far south, giving bad weather and rains as far as Valdivia; 15 mm. fell at this farthest point where rain occurred.

From the 16th to 23d the weather was in general better, under prevailingly high pressure in the south.

On the 23d an important depression began to influence southern South America, bringing on a period of bad weather and rains which lasted until the 29th, when the pressure became definitely higher. The maximum precipitation was observed on the 29th, at Valdivia, 44 mm.

A new barometric decline began on the 30th.

METEOROLOGICAL SUMMARY FOR BRAZIL, APRIL, 1926

By FRANCISCO SOUZA, Acting Director

[The Meteorological Office, Rio de Janeiro]

During April the circulation of the lower atmosphere continued about as intense as in the preceding month, the anticyclones in the meantime being observed to move along meridional paths. The semipermanent anticylone of the Atlantic appears to have had less influence over the continent. The continental depression, and those migrating from high latitudes, were less active.

Over the whole country the amount of rainfall received was rather great, the rivers Poty and Saõ Francisco continuing in a state of flood, as did also the Parintins, the Mearim, and the Itapicurú. In the Province of Rio Grande do Sul excessive rainfalls were recorded, which were abnormal for the season.

The weather in Rio de Janeiro was in general unsettled, 13 cloudy days being recorded, with the rainiest period observed on the 14th–17th. Temperature remained below normal during the last two decades of the month, though in the first decade some high temperatures occurred.

Crops in general did well, except milo, which in Rio Grande do Sul suffered from lack of rain, and coffee which in some localities did not come up to expectations.

The yield of the cereal and vegetable crops was satisfactory, though the same was not the case with beans in the central region of the country.—*Translation.*

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SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING MAY, 1926

By HERBERT H. KIMBALL, Solar Radiation Investigations

For a description of instruments and exposures and an account of the method of obtaining and reducing the measurements, the reader is referred to the REVIEW for January, 1924, **52** : 42, January, 1925, **53** : 29, and July, 1925, **53** : 318.

From Table 1 it is seen that solar radiation intensities averaged slightly above the normal for May at Washington and below the normal at Madison and Lincoln.

At Madison a mid-day intensity of 1.48 gr. cal./min./cm² on the 12th approximates closely to the extreme intensity for May of 1.49 recorded on May 9, 1923.

Table 2 shows an excess in the amount of the radiation received on a horizontal surface from the sun and sky at all three stations, which is most pronounced at Washington.

Skylight polarization measurements made on seven days at Washington give a mean of 60 per cent, with a maximum of 65 per cent on the 27th and 29th. These are higher than the corresponding averages for May at Washington. Measurements made on five days at Madison give a mean of 53 per cent, with a maximum of 63 per cent on the 11th. These are below the corresponding averages for May at Madison.

TABLE 1.—*Solar radiation intensities during May, 1926*

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e.	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
May 1	8.48				0.89						9.47
4	3.99	0.64	0.77	0.91	1.18	1.40	1.06	0.94			3.99
5	2.74	0.75	0.84	0.92	1.19		1.00				2.87
7	9.83		0.50			1.10					9 14
8	7.57	0.49	0.60	0.75	0.94						7.04
11	5.36		0.81	0.98	1.19	1.40	1.04	0.80	0.67	0.56	3.81
17	7.87		0.74	0.81	0.96	1.16					7.87
18	10.97					1.27					10.21
19	14.10	0.65	0.76	0.87	0.92						14.60
24	6.27						1.00	0.85			7.87
25	8.18					1.27	0.92				4.75
26	6.02					1.28					5.56
27	6.27			0.85	1.00	1.38					6.27
29	7.87		0.60	0.75	0.99	1.29					5.16
Means		**0.63**	**0.72**	**0.86**	**1.03**	**1.28**	**1.00**	**0.86**	**(0.67)**	**(0.56)**	
Departures		**±0.00**	**+0.01**	**+0.05**	**+0.05**	**±0.00**	**+0.02**	**+0.07**	**−0.02**	**−0.04**	

* Extropolated.

TABLE 1.—*Solar radiation intensities during May, 1926*—Contd.

MADISON, WIS.

Date	Sun's zenith distance										
	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e.	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
May 1	5.56			0.69	0.91	1.29					6.76
5	6.02					1.33					9.83
6	6.50				1.03	1.33					6.02
10	4.75					1.38					5.79
11	5.16			1.09	1.24						6.27
12	5.56					1.54					5.79
15	4.75					1.34					5.74
17	7.29				1.10	1.28					7.57
20	7.04					1.22					6.76
22	5.16					1.24					5.36
27	6.27					1.39					6.76
28	7.57				1.03	1.32					8.18
Means				**(0.89)**	**1.06**	**1.33**					
Departures				**−0.06**	**−0.05**	**−0.02**					

LINCOLN, NEBR.

Date	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
May 3	4.57			0.69	0.88	1.21					5.56
4	7.04					1.24	0.95	0.78	0.64	0.53	6.27
5	9.47		0.76		1.10						10.21
14	5.56	0.70	0.88	0.92	1.17						3.15
15	4.57		0.91	1.00	1.22	1.47	1.18	1.03	0.90		4.37
19	8.18		0.42	0.54	0.77		0.95	0.75	0.68		6.27
24	13.13			0.91	1.07	1.28					13.13
Means		**(0.70)**	**0.74**	**0.81**	**1.04**	**1.30**	**1.03**	**0.85**	**0.74**	**(0.53)**	
Departures		**−0.01**	**−0.06**	**−0.14**	**−0.09**	**−0.08**	**−0.07**	**−0.07**	**−0.04**	**−0.19**	

*Extrapolated.

TABLE 2.—*Solar and sky radiation received on a horizontal surface*

[Gram-calories per square centimeter of horizontal surface]

Week beginning—	Average daily radiation					Average daily departure from normal		
	Washington	Madison	Lincoln	Chicago	New York	Washington	Madison	Lincoln
1926	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Apr. 30	498	506	561	433	438	+49	+60	+109
May 7	552	494	318	423	481	+92	+33	−173
14	489	465	591	383	350	+21	−10	+81
21	568	534	630	329	500	+90	+57	+121
28	532	537	564	461	385	+44	+54	+41
Excess since first of year on June 3						+2,765	+2,758	+574

CORRECTION TO TABLE 2 FOR JANUARY AND FEBRUARY, 1926

Owing to a misunderstanding the sensitivity of the recorder in use at Chicago was changed while undergoing repairs in December, 1925. In consequence the daily average for each week for that station published in the Monthly Weather Review for January and February, 1926, should be multiplied by 1.75.

WEATHER OF NORTH AMERICA AND ADJACENT OCEANS

NORTH ATLANTIC OCEAN

By F. A. YOUNG

During May the North Atlantic was unusually free from storms, and the weather was a great contrast to the generally stormy conditions that had prevailed during a large part of the period since the summer of 1925. During the current month the greatest number of gales occurred in the square between the 40th and 45th parallels and the 50th and 55th meridians, where they were reported on four days, while over the middle and extreme eastern sections of the steamer lanes stormy weather was rare.

Fog was unusually prevalent over the Grand Banks, where it was reported on 18 days, and was also more frequent than usual along the American coast and over the greater part of the steamer lanes.

TABLE 1.—*Averages, departures, and extremes of atmospheric pressures at sea level, 8 a. m. (75th meridian), North Atlantic Ocean, May, 1926*

Station	Average pressure	Departure [1]	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
St. Johns, Newfoundland	29.81	−0.19	30.34	30th	29.12	12th.
Julianehaab, Greenland	[2] 29.82	([3])	30.32	4th	29.26	17th.
Nantucket	29.87	−0.14	30.32	28th [4]	29.38	9th.
Hatteras	29.93	−0.08	30.26	29th [4]	29.58	9th.
Key West	29.98	0.00	30.12	18th	29.82	8th.
Swan Island	29.85	−0.02	29.94	15th [4]	29.72	8th.
New Orleans	29.99	−0.03	30.18	16th	29.76	11th.
Turks Island	30.01	−0.01	30.14	18th	29.90	5th. [4]
Bermuda	30.04	−0.04	30.28	2d	29.58	7th.
Horta, Azores	30.07	−0.07	30.52	17th	29.60	5th.
Lerwick, Shetland Islands	29.88	−0.08	30.27	2d	29.31	12th.
Valencia, Ireland	29.91	−0.04	30.30	6th	29.43	12th.
London	29.90	−0.02	30.14	25th	29.58	30th.

[1] From normals shown on H. O. Pilot Chart, based on observations at Greenwich mean noon, or 7 a. m., 75th meridian.
[2] Mean of 28 observations; three days missing.
[3] New station; no normal established.
[4] And on other dates.

The mean pressure of 29.82 inches at Julianehaab shows a considerable increase over the April mean of 29.29, and the former reading is probably not far from the normal for that region.

On the 1st, St. Johns, Newfoundland, was near the center of a depression, accompanied by light to moderate winds. On the same day a second LOW was central near 45° N., 18° W., and a northwest gale, force 10, was reported in 41° N., 24° W., although no other vessel in the vicinity encountered winds of higher force than 7.

On the 2d the western LOW was central near 45° N., 43° W., and the eastern near 48° N., 10° W. At the time of observation on the 2d favorable weather was the rule over practically the entire ocean, although later in the day and on the morning of the 3d moderate gales prevailed over the westerly quadrants of the eastern LOW, that on the latter date was central near 43° N., 42° W. This depression moved eastward, and on the 4th was about 300 miles west of the Azores, winds of force 3 to 7 drevailing in the vicinity. This LOW moved but little during the next 24 hours, and the weather conditions differed slightly from those of the previous day.

Charts VIII to XI show the conditions from the 6th to 9th, inclusive.

On the 10th a depression was off the American coast between New York and Hatteras. This LOW moved northeastward and on the 11th was central near Halifax, and on the 12th off the west coast of Newfoundland. On the 10th and 11th moderate weather prevailed, but on the 12th strong southerly gales were encountered over a limited area near 40° N., 50° W.

On the 11th there was also a LOW in the eastern section of the northern steamer lanes. On the 12th this LOW was over Ireland, and on both dates northerly to northwesterly gales occurred between the 25th meridian and European coast.

On the 13th an area of low pressure surrounded Newfoundland, while comparatively high pressure with moderate weather was the rule over the rest of the ocean.

On the 14th the region in the vicinity of New York was covered by a slight depression, while the weather conditions were much the same as on the 13th. This LOW moved slowly along the coast and on the 15th was in the vicinity of Nova Scotia.

On the 16th another LOW appeared off the Virginia capes and westerly gales were encountered in the southerly quadrants, although fine weather continued over the rest of the ocean. On the 17th this LOW was central a short distance south of Nantucket and on the 18th off the coast of Nova Scotia, while the westerly gales still held in the southerly quadrants. This low-pressure area remained in the vicinity of the Canadian coast until the 23d, but was not accompanied by any severe weather.

On the 19th there was a disturbance over the eastern section of the steamer lanes and moderate gales prevailed between the 15th and 25th meridians.

On the 21st a LOW between Hatteras and Charleston was accompanied by strong southwesterly gales along the coast.

From the 22d to 25th an area of low pressure covered the middle and eastern section of the steamer lanes, and during this period westerly gales prevailed between the 25th and 45th meridians.

On the 24th the American S. S. *Hannawa*, from Cristobal to New York, while in 24° 07′ N., 80° 34′ W., observed a large waterspout; duration, 15 minutes.

From the 25th to 31st low pressure prevailed generally over the eastern section of the northern steamer lanes, although during this period few reports of heavy winds were received.

On the 28th a shallow depression covered the region between the Bermudas and coast of Georgia, and northeasterly gales were encountered by vessels in the northwesterly quadrants.

On the 29th and 30th gales were reported near the 40th parallel, between the Azores and 45th meridian, although the majority of vessels in this region experienced light to moderate winds.

On the 31st favorable weather was the rule except for a limited area over the steamer lanes between the 45th and 60th meridians where northerly gales prevailed, accompanied by comparatively high barometric readings.

OCEAN GALES AND STORMS MAY, 1926

Vessel	Voyage		Position at time of lowest barometer		Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Highest force of wind and direction	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				Inches					
Bird City, Am. S. S	New York	Copenhagen	42 44N.	44 26W.	May 1	3a., May 2	May 2	29.33	S	SSW., 7	W	—, 10	S.-SSW.
Leviathan, Am. S. S	do	Cherbourg	41 15N.	45 49W.	3	4p., 3	3	29.40	NW	NW., 6	N	NW., 8	NW.-NNE.
Sinsinawa, Am. S. S	Gibraltar	New York	37 00N.	32 30W.	6	1a., 6	6	29.45	SW	W., 8	W	SW., 9	SW.-W.
Giuseppi Verdi, Ital. S. S.	New York	Lisbon	40 15N.	52 30W.	7	Mdt., 7	8	29.49	SE	SE., 8	SSE	SE., 8	SE.-SSE.
Tomalva, Am. S. S	Rotterdam	New York	40 59N.	57 07W.	7	4a., 8	9	28.95	ESE	S., 8	SW	W., 9	S.-SW.-W.
Boston City, Br. S. S	New York	Bristol	50 30N.	16 00W.	11	4a., 11	12	29.60	W	WNW., —	NW	—, 9	W.-WNW.
Utah, Fr. S. S	Havre	New York	40 28N.	51 20W.	12	4p., 12	12	29.40	SW	S., 9	W	S., 10	S.-W.-NW.
Presidente Wilson, Ital. S. S.	Lisbon	do	40 54N.	60 09W.	14	3a., 15	15	29.77	S	S., —	W	—, 8	S.-SW.-W.
Laurel, Am. S. S	Cristobal	do	31 04N.	74 06W.	16	1a., 16	17	29.71	SSW	W., 8	NW	W., 9	W.-NW.
Hog Island, Am. S. S	Palmos	do	35 45N.	63 05W.	17	Mdt., 17	19	29.70	S	S., 7	SW	S., 8	WSW.-S.-SW.
Hardenberg, Du. S. S	Rotterdam	Boston	40 10N.	47 55W.	18	4a., 19	19	29.91	SSW	SW., 5	SW	—, 8	S.-SW.
Cripple Creek, Am. S. S.	Galveston	Liverpool	49 10N.	19 10W.	18	5p., 19	19	29.46	NW	NW., 8	NW	NW., 9	NW.-WNW.
M. F. Elliott, Am. S. S	New York	Texas City	37 38N.	74 22W.	20	3a., 21	21	29.87	SW	SW., 8	SW	—, 10	S.-SW.
Western Plains, Am. S. S.	Antwerp	Philadelphia	47 20N.	28 39W.	22	4p., 22	23	29.60	SW	SW., 7	W	—, 10	SW.-W.
Housatonic, Br. S. S	Norfolk	London	47 35N.	24 00W.	22	—, 26	26	29.63	WNW	SW., 7	SW	WNW., 8	WSW.-S.-SW.
Ossa, Am. S. S	Alexandria	Boston	40 33N.	36 23W.	28	10p., 28	29	29.88	WNW	WNW., —	NW	NW., 8	WNW.-NW.
Kendal Castle, Br. S. S	Algiers	New York	38 43N.	62 00W.	29	8p., 29	30	29.87	N	NE., 8	N	NE., 8	S.-W.-NE.
Tomalva, Am. S. S	New York	Rotterdam	39 55N.	63 40W.	29	4a., 30	31	30.06	NNE	NNE., 8	NNE	NNE., 8	Steady.
NORTH PACIFIC OCEAN													
Pres. Wilson, Am. S. S	San Francisco.	Yokohama	34 15 N.	160 48 E.	Apr. 30	6 p., Apr. 30	May 1	29.74	SW	SW., 7	W	W., 9	SW.-W.
West Himrod, Am. S. S.	Yokohama	Seattle	44 56 N.	161 31 E.	30	8p., 30	1	28.94	E	E., 7	NNE	ENE., 9	E.-NE.
Akibasan Maru, Jap. S. S.	Tacoma	Yokohama	47 28 N.	163 55 E.	30	10 a., 1	1	29.31	ENE	NE., 9	N	NE., 9	E.-NE.-N.
Myriam, Fr. S. S	China	San Francisco.	39 25 N.	176 40 E.	May 1		1	29.31		SSW., 9		SSW., 9	
Liebre, Am. S. S	Tsumuri	San Pedro	45 46 N.	153 22 W.	3		3	29.33		WSW., 9		WSW., 9	
Oakridge, Am. S. S	Portland	Yokohama	35 25 N.	141 00 E.	7	2 a., 8	8	29.57	S	SSW	SSW	S., 8-9	SSW.-NW.
Pres. Madison, Am. S. S.	Seattle	do	41 51 N.	151 25 E.	8	6 a., 8	8	29.52	S	S., 8	S	S., 8	S.-SSE.
Iyo Maru, Jap. S. S	Victoria	do	46 20 N.	159 40 E.	8		8	29.86		S., 8		S., 8	
Yokohama Maru, Jap. S. S.	Yokohama	Victoria	48 56 N.	143 53 W.	8	5, 30 p., 10	11	29.02	N	SE., —	SE	—, 8	N.-E.-SE.
Colombia, Am. S. S	Balboa	Los Angeles	29 08 N.	115 37 W.	9	6 p., 8	9	29.94	NW	NW., 8	NW	NW., 8	Steady.
Harold Dollar, Am. S. S.	Karatsu	San Francisco.	42 17 N.	131 02 W.	9	8 a., 10	10	29.95	ESE	ESE., 8	S	ESE., 8	ESE.-S.-ESE.
Havre Maru, Jap. S. S	Muroran	Grays Harbor.	47 40 N.	174 15 E.	9	2 a., 11	12	29.75	SSE	SE., —	E	E., 8	SE.-E.
West Himrod, Am. S. S.	Yokohama	Seattle	50 02 N.	139 20 W.	10	8 a., 10	10	29.48	E	E., 8	SE	E., 8	E.-SE.
Makiki, Am. S. S	Puget Sound	Honolulu	45 18 N.	130 45 W.	10	3, 17 a., 10	10	29.77	ESE	ESE., —	SE	—, 10	Steady.
West Kader, Am. S. S	Otaru	San Francisco.	45 06 N.	145 17 W.	10	12.30 a., 10	11	29.23	S	S., 9	SSE	S., 10-11	Steady S.
Crosskeys, Am. S. S	Tsingtao	Seattle	50 00 N.	150 55 W.	11	8 a., 12	12	29.46	N	NW., 7	NW	NW., 8	NW.-NNW.
West Prospect, Am. S. S.	San Francisco.	Yokohama	34 54 N.	174 44 E.	14	12 p., 14	15	30.00	SSE	SSE., 3	WNW	SW., 8	SSE.-SW.-WNW.
Arizona Maru, Jap. S. S.	Yokohama	Victoria	51 20 N.	149 50 W.	23	4 p., 23	25	29.40	NW	NW., 4	W	WNW., 8	NW.-W.
William Campion, Am. S. S.	Balboa	San Pedro	14 18 N.	93 39 W.	23	4 a., 23	24	29.74	W	W., —	N	N., 8	W.-NE.-N.
Admiral Watson, Am. S. S.	Yakutat	Juneau	59 41 N.	143 31 W.	28	8 a., 28	29	29.38	SE	NW., 4	SE	SE., 8	Steady.
Gyokoh Maru, Jap. S. S.	Otaru	Coos Bay	49 16 N.	146 42 W.	29	1 p., 30	31	29.66	NE	NE., 8	W	NE., 8	NE.-N.-W.
Akagisan, Maru, Jap. M. S.	Yokohama	San Francisco.	46 25 N.	150 20 W.	29	4 a., 30	30	29.61	NE	NNW., 8	NW	NNW., 8	NE.-N.-NW.
H. F. Alexander, Am. S. S.	New York	Seattle	38 00 N.	124 00 W.	29	10 p., 29	30	29.90	NW	NW., 8	NW	NW., 8	Steady.
SOUTH ATLANTIC OCEAN													
Alchiba, Du. S. S	Rotterdam	Buenos Aires	30 39 S.	48 27 W.	Apr. 30	5p., Apr. 30	May 1	29.88	SW	SW., 8	S	SW., 9	Steady
SOUTH PACIFIC OCEAN													
West Nivaria, Am. S. S	San Pedro	Auckland	36 30 S.	175 20 E.	May 3		May 3	29.36	NW	NW., 9	W	—, 10	NW.-W.
Sonoma, Am. S. S	San Francisco.	Sydney	26 00 S.	167 14 E.	15	4p., May 15	18	29.67	NNE	NNE., 4	S	—, 8	NNE.-SE.

NORTH PACIFIC OCEAN

By F. G. Tingley

May, as a rule, is a pleasant month on the North Pacific Ocean, the disturbing temperature differences between the ocean and neighboring land areas which characterize the cold season having practically disappeared. Reports at hand indicate that May, 1926, was no exception to the general rule, a considerable number of vessels having made the trans-Pacific voyage under very favorable weather conditions. However a few disturbances may be noted which occasioned at intervals fresh to strong gales.

At the beginning of the month there was a rather energetic depression in the vicinity of 45° N., 160° E., in which several reporting vessels were involved, including the British S. S. *Philoctetes* in addition to those mentioned in the table of gales. Following this, on the 3d, vessels in the eastern part of the northern steamer lane experienced southwesterly gales, incident to the deepening of a depression over the Gulf of Alaska.

From the 8th to the 12th southerly gales were general in both the eastern and western sections of the steamer lane, this activity being associated with an incursion of high pressure over Bering Sea and a consequent deepening of two adjacent depressions, one southeast, the other southwest of the high pressure area. Details of the resulting weather will be found in the table of gales.

Following the abatement of these storms conditions were generally quiet until near the close of the month, when a second incursion of high pressure over Bering Sea occasioned fresh northwesterly gales which reached southward over the Gulf of Alaska to the steamer lane where several vessels were involved on the 28th to 30th.

May was the seventh consecutive month with pressure averaging below normal in the region of the Aleutian Islands and Gulf of Alaska. The average monthly deficiency of pressure at Dutch Harbor for the period from November, 1925, to May, 1926, inclusive, was 0.30 inch; at Kodiak, 0.24 inch, and at Juneau, 0.13 inch. Only in two months during this period did pressure rise to normal or above at any of these stations, in December reaching normal at Dutch Harbor and in March an average of +0.05 inch at Juneau.

It is interesting to consider this pressure anomaly in connection with general weather conditions in adjacent regions. At Honolulu an unprecedented drouth remained unbroken, with a continuation of unusual easterly winds. Temperature there was again above normal—after a subnormal temperature in April which had broken, temporarily, a period of eight months of excessive temperature. On the American mainland temperatures over the northwestern United States and western Canada were almost continuously above normal, at times by large amounts.

Table 1.—*Averages, departures, and extremes of atmospheric pressure at sea level at indicated hours, North Pacific Ocean, May, 1926*

Station	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inch*	*Inches*		*Inches*	
Dutch Harbor [1] [4]	29.76	−0.16	30.36	11th	29.00	2d.
St. Paul [1]	29.93	+0.07	30.62	11th	29.32	Do.
Kodiak [1]	29.65	−0.22	30.44	10th	28.86	Do.
Midway Island [1]	30.05	−0.04	30.22	3d	29.86	9th.
Honolulu [2]	30.08	+0.02	30.20	5th	29.91	Do.
Juneau [2]	29.79	−0.20	30.46	10th	29.16	4th.
Tatoosh Island [2] [3]	30.01	−0.03	30.36	30th	29.50	6th.
San Francisco [2] [3]	30.02	+0.03	30.22	10th	29.90	Do.
San Diego [2] [3]	29.96	+0.03	30.08	15th	29.85	12th.

[1] P. m. observations only.
[2] A. m. and p. m. observations.
[3] Corrected to 24-hour mean.
[4] Twenty-eight days.

Fog appears not to have been more prevalent than usual for May. Between the 3d and 12th it was noted very generally throughout the northern steamer lane. From the 16th to the 20th it was restricted for the most part to American coastal waters and the region southeast of the Kuril Islands and the same was true of the period from the 28th to the end of the month. At other times the ocean was practically free of fog, although an exception should be noted on the 10th and 11th, when it was observed by several vessels leaving and arriving at Balboa.

The following report of waterspouts has been received from the S. S. *John D. Archbold*, Capt. Geo. E. Bridgett; observer, Mr. H. Thorsen: "On May 25, in latitude 14° 07′ N., longitude 95° 17′ W., at 14 h. 14 m. G. C. T., observed large waterspout making up approximately 6 miles NNE. of vessel, moving at a rapid speed in a NE.-SW. direction. Ship's course 295°, true. Fifteen minutes later a second large spout made up a little in advance of the first one. At 14 h. 44 m. the first, and larger, spout overtook the second and both disappeared. A few minutes later the vessel ran through a moderate wind and rain squall."

BAY OF BENGAL CYCLONE

Press dispatches from Rangoon, Burma, say that a violent tropical storm from the Bay of Bengal struck the Arakan coast on Wednesday evening, May 26, 1926. Government buildings were reported destroyed at Akyab. A tidal wave ascended the Naaf River and "swept away villages to beyond Maung-daw, 50 miles inland." The loss to life was considered to be at least 2,800.—*W. E. H.*

DETAILS OF THE WEATHER IN THE UNITED STATES

GENERAL CONDITIONS

Mostly a warm and dry month; cool in southern Rocky Mountain region, along the Gulf and Atlantic coasts, in New England and the eastern part of the lake region. Monthly extremes of temperature were exceptional; in some localities the highest temperature of record for the month occurred; in still others the minimum for the month was as low as previously recorded and in a few cases 1 or 2 degrees lower.

More than the normal rain fell in the southern Rocky Mountain region, in Washington, Texas, and at isolated places elsewhere.

CYCLONES AND ANTICYCLONES

By W. P. DAY

The month was typical with respect to the general character of the HIGHS and LOWS, which began to resemble the less active summer types. The relatively large number of LOWS plotted, 17, was due in part to the development of small barometric disturbances in the troughs of low pressure, which carried on for a few observations and then dissipated, followed by new developments as the trough moved slowly eastward.

The HIGHS were generally weak and few in number, there being only about half the number noted in February and March of this year. The minimum number for any month usually occurs in June in the United States, corresponding to the summer solstice with its lessened polar-equatorial temperature gradient.

FREE-AIR SUMMARY

By V. E. JAKL

Free-air temperature departures from the normal on the whole followed those at the surface, and consequently were practically the same as those shown on Chart III, this REVIEW. Free-air relative humidities were about normal.

Resultant winds showed no important departures from the normal. (See Table 2.) Directions were generally southwesterly near the surface, changing gradually to about west-northwest at altitudes of 4,000 meters and above. The best example of east component winds extending to high altitudes was observed on the 11th and 12th at Lansing, Ellendale, Madison, and Royal Center, in connection with an extensive HIGH covering northern and western sections, with a LOW over the southeastern States. The highest velocity was 46 m. p. s. from the north-northwest at 2,750 meters, recorded at Burlington on the 12th, in the rear of a LOW over Newfoundland.

A number of interesting examples of vertical convectional currents due principally to insolation are shown by two-theodolite pilot-balloon observations at Ellendale. The effect of a rapid rise in surface temperature on the 4th was shown by an ascending current in the afternoon which extended without interruption and at an almost uniform rate of about 4 m. p. s. up to 4,200 meters. The kite flight on this date, reaching 3,500 meters, showed a dry adiabatic lapse rate throughout the extent of the observation. On the 14th an observation at 1 p. m. showed an ascending current of about 1.5 m. p. s., extending to 2,000 meters, while at 4 p. m. a descending current of about 0.8 m. p. s. extended from 900 meters to 1,700 meters. The kite flight showed a dry adiabatic rate to 2,100 meters, above which was an inversion. On the 17th the balloon encountered a descending current of about 2 m. p. s. from 900 meters to 1,300 meters and an ascending current of about 1.7 m. p. s. from 2,000 meters to 3,400 meters. This observation was also made under conditions of high lapse rate. Incidentally in all these three cases, relative humidities as far aloft as observed were rather low.

Another instance of ascending current under quite different circumstances, viz, in a thunderstorm, is shown by a kite flight at Royal Center on the 17th. An extract from the report of the station, also the record of this flight, follows:

> The week was generally showery with thunderstorms, which made kite flying rather dangerous. On the 17th the kites were struck by lightning when they were caught in a quickly developing thunderstorm that was attended by rain and hail. The record shows a very rapid ascent of the kites beginning at 2:35 p. m. and continuing until the wire was destroyed by lightning at 2:54 p. m. This rapid rise was due to the strong ascending current under the storm cloud. The headkite continued to rise for a minute after the wire was burned and then fell abruptly, its fall being due either to having become heavy with moisture or having fallen out of the ascending current.

Altitude m. s. l.	Temperature	$\frac{\Delta t}{100\ m}$	Relative humidity	Wind	
				Direction	Velocity
Meters	° C.		%		*M. p. s.*
225 (surface)	25.9		44	W	5
574	21.7	1.20	44	W	7
1406	11.8	1.19	69	W	12
2163	5.2	.87	94	W	8
2605	3.2	.45	95	W	8

Peculiarly, the lapse rate in this record diminishes with altitude, while the humidity increases to practically the saturation point at the top. It is therefore to be inferred that the thunderstorm was not a purely local one and that the strong ascending current was due to causes other than simple thermal convection.

The occasionally observed instances of a reversal of the normal increase of wind velocity with altitude are well illustrated in a number of afternoon observations. Morning observations under these conditions show a rapid increase in velocity for the first few hundred meters, followed by a steady decrease to some fairly high altitude. The convection that later arises following the disappearance of the nocturnal temperature inversion causes an increase in surface velocity, and therefore a more or less regular fall in velocity from the ground upward results. A well-defined example was recorded at Ellendale on the 1st, when a north wind diminished gradually from a surface velocity of 13 m. p. s. to 1 m. p. s. at 3,200 meters, above which it changed abruptly with increasing velocity to south-southwest. Ordinarily, however, under these conditions, some increase in velocity with altitude is still evident in the first few hundred meters, even in midafternoon, as at Broken Arrow on the 27th, where a south-southeast wind increased from 10 m. p. s. to 18 m. p. s. in the first 400 meters, but thence diminished steadily to 1 m. p. s. at 2,600 meters.

An airplane observation at the Naval Air Station at Washington on the 27th shows the possibilities of obtaining free-air records to great altitudes by this method. The flight extended to 6,165 meters altitude, in a wind ranging from light northeast on the ground to strong northwest in the upper few thousand meters. The lapse rate averaged 0.42, with small inversions at 1,300 meters and 2,400 meters.

637—26——3

TABLE 2.—*Free-air resultant winds (m. p. s.) during May, 1926*

Altitude, m. s. l.	Broken Arrow, Okla. (233 meters)				Due West, S. C. (217 meters)				Ellendale, N. Dak. (444 meters)				Groesbeck, Tex. (141 meters)				Royal Center, Ind. (225 meters)				Washington, D. C. (34 meters)	
	Mean		8-year mean		Mean		6-year mean		Mean		9-year mean		Mean		8-year mean		Mean		8-year mean		Mean	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Meters																						
Surface	S. 13° W.	3.1	S. 13° E.	1.7	S. 79° W.	1.6	W.	0.5	N. 5° W.	0.5	N. 14° E.	0.4	S. 18° W.	3.6	S. 11° E.	2.0	S. 61° W.	1.7	N. 82° W.	0.2	N. 26° W.	0.7
250	S. 10° W.	3.4	S. 12° E.	1.8	S. 75° W.	2.1	S. 80° W.	0.6					S. 15° W.	3.8	S. 7° E.	2.6	S. 66° W.	1.9	S. 76° W.	0.3		
500	S. 24° W.	4.5	S. 2° E.	2.5	S. 82° W.	3.9	S. 85° W.	1.3	N. 9° W.	0.5	N. 26° E.	0.2	S. 14° W.	5.0	S.	3.8	S. 67° W.	3.3	S. 65° W.	1.2	N. 40° W.	2.3
750	S. 23° W.	4.4	S. 6° W.	2.9	S. 85° W.	4.8	S. 84° W.	1.9	N. 8° W.	0.2	S. 14° E.	0.4	S. 15° W.	5.4	S. 8° W.	4.3	S. 84° W.	3.9	S. 74° W.	1.8	N. 50° W.	3.6
1,000	S. 33° W.	4.6	S. 21° W.	3.0	S. 85° W.	5.6	S. 88° W.	2.4	N. 11° W.	0.1	S. 8° W.	0.7	S. 24° W.	5.5	S. 20° W.	4.7	N. 85° W.	4.6	S. 85° W.	2.4	N. 42° W.	4.7
1,250	S. 38° W.	4.4	S. 36° W.	3.2	S. 84° W.	6.5	S. 80° W.	3.5	S. 26° W.	0.7	S. 24° W.	1.0	S. 29° W.	5.3	S. 27° W.	4.9	N. 77° W.	5.1	N. 84° W.	2.9	N. 39° W.	6.0
1,500	S. 45° W.	4.4	S. 47° W.	3.6	S. 79° W.	7.0	S. 78° W.	4.6	S. 31° W.	1.0	S. 36° W.	1.4	S. 35° W.	4.5	S. 36° W.	4.6	N. 82° W.	5.7	N. 86° W.	3.2	N. 42° W.	7.9
2,000	S. 54° W.	4.8	S. 64° W.	4.1	S. 78° W.	8.7	S. 80° W.	6.0	S. 69° W.	3.0	S. 58° W.	2.5	S. 56° W.	4.0	S. 49° W.	4.6	N. 80° W.	6.1	N. 89° W.	5.6	N. 50° W.	8.7
2,500	S. 66° W.	4.4	S. 82° W.	5.0	S. 76° W.	12.4	S. 82° W.	8.0	S. 75° W.	4.4	S. 64° W.	3.9	S. 59° W.	5.0	S. 63° W.	5.0	N. 80° W.	6.5	N. 84° W.	5.3	N. 57° W.	9.5
3,000	S. 68° W.	4.9	N. 87° W.	5.7	S. 77° W.	14.1	S. 80° W.	8.1	S. 70° W.	5.8	S. 71° W.	5.3	S. 72° W.	7.1	S. 76° W.	6.2	N. 87° W.	7.7	N. 74° W.	6.9	N. 68° W.	8.7
3,500	S. 60° W.	5.3	N. 81° W.	7.1	S. 80° W.	14.6	S. 88° W.	9.6	S. 68° W.	7.4	S. 78° W.	6.0	S. 87° W.	9.0	S. 86° W.	7.4	S. 7° W.	3.8	N. 72° W.	7.0	N. 67° W.	8.4
4,000	S. 65° W.	8.5	N. 83° W.	8.0	N. 68° W.	21.0	N. 74° W.	11.4	S. 87° W.	11.5	N. 87° W.	7.8	S. 84° W.	11.4	N. 75° W.	9.8	S. 45° W.	4.5	N. 85° W.	6.4	N. 55° W.	10.0
4,500	S. 67° W.	7.6	N. 79° W.	8.8					N. 57° W.	12.4	N. 68° W.	6.2									N. 43° W.	11.6
5,000	S. 17° W.	6.4	W.	6.4																	N. 26° W.	13.6

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during May, 1926*

TEMPERATURE (°C.)

Altitude, m. s. l.	Broken Arrow, Okla. (233 meters)		Due West S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Groesbeck, Tex. (141 meters)		Royal Center, Ind. (225 meters)		*Washington, D. C. (7 meters)
	Mean	Departure from 8-year mean	Mean	Departure from 6-year mean	Mean	Departure from 9-year mean	Mean	Departure from 8-year mean	Mean	Departure from 8-year mean	Mean
Meters											
Surface	20.7	+1.2	19.9	−0.4	17.0	+3.5	22.2	−0.3	17.2	+0.7	15.6
250	20.6	+1.2	19.6	−0.4			21.3	−0.3	17.0	+0.8	14.6
500	19.3	+1.7	17.6	−0.1	16.4	+3.3	19.6	−0.2	15.2	+1.5	14.2
750	17.9	+1.8	15.9	0.0	14.4	+3.0	18.0	−0.4	14.2	+2.3	13.1
1,000	16.5	+1.6	14.3	−0.1	13.1	+3.2	17.1	−0.1	13.0	+2.6	11.6
1,250	15.1	+1.4	12.6	−0.3	12.1	+3.6	16.0	−0.2	11.6	+2.7	10.2
1,500	13.5	+1.1	11.1	−0.4	10.6	+3.6	15.0	−0.1	10.1	+2.7	9.0
2,000	10.4	+0.7	7.7	−1.1	7.6	+3.6	12.2	−0.5	7.7	+2.9	6.7
2,500	7.5	+0.5	5.3	−0.8	4.3	+3.3	9.7	−0.3	5.5	+3.2	4.1
3,000	4.3	+0.3	2.5	−0.8	1.0	+2.9	6.6	−0.6	2.9	+3.4	1.3
3,500	1.0	+0.1	−0.9	−1.3	−2.5	+2.2	3.6	−0.6	0.3	+3.7	−2.0
4,000	−1.9	+0.3	−5.1	−2.3	−6.0	+1.8	0.5	−0.7	−3.5	+2.7	−5.2
4,500	−4.7	+0.3			−10.2	+1.0					−8.3
5,000	−7.1	+0.2									−10.9

RELATIVE HUMIDITY (%)

Altitude, m. s. l.	Broken Arrow Mean	Departure	Due West Mean	Departure	Ellendale Mean	Departure	Groesbeck Mean	Departure	Royal Center Mean	Departure	*Washington Mean
Surface	64	−6	61	−1	51	−9	73	+2	64	+2	74
250	64	−6	61	−1			74	+2	64	+2	69
500	61	−8	60	−3	51	−9	74	+1	62	0	62
750	60	−8	60	−4	52	−7	75	+3	60	−2	59
1,000	59	−8	60	−4	52	−7	70	+1	61	−1	60
1,250	58	−7	61	−3	50	−9	65	0	61	−1	62
1,500	58	−5	62	−2	50	−9	59	−2	61	−1	64
2,000	54	−6	62	0	50	−9	54	0	58	−1	65
2,500	53	−4	53	−6	49	−9	47	−4	49	−5	63
3,000	54	−1	50	−5	49	−7	49	−1	43	−7	61
3,500	53	−2	54	+3	56	+3	43	−5	45	−6	64
4,000	50	−6	62	+15	57	+5	45	−5	69	+19	63
4,500	48	−6			61	+8					58
5,000	54	−6									58

VAPOR PRESSURE (*mb.*)

Altitude, m. s. l.	Broken Arrow Mean	Departure	Due West Mean	Departure	Ellendale Mean	Departure	Groesbeck Mean	Departure	Royal Center Mean	Departure	*Washington Mean
Surface	15.67	−0.50	13.82	−1.08	9.58	+0.25	19.57	+0.11	12.82	+0.95	13.18
250	15.52	−0.50	13.55	−1.09			18.77	+0.09	12.60	+0.95	11.57
500	13.75	−0.44	11.86	−1.10	9.36	+0.27	16.93	−0.01	10.95	+0.96	10.06
750	12.58	−0.20	10.70	−1.10	8.37	+0.35	15.52	+0.17	9.81	+0.92	8.98
1,000	11.55	−0.16	9.79	−0.98	7.70	+0.42	13.55	−0.07	9.21	+1.15	8.30
1,250	10.41	−0.14	8.97	−0.86	7.07	+0.38	11.63	−0.24	8.54	+1.24	7.81
1,500	9.37	+0.08	8.16	−0.77	6.46	+0.38	9.82	−0.45	7.90	+1.34	7.44
2,000	6.92	−0.47	6.28	−0.98	5.32	+0.40	7.50	−0.27	6.63	+1.52	6.48
2,500	5.56	−0.25	4.30	−1.52	4.21	+0.32	5.55	−0.68	4.85	+1.06	5.11
3,000	4.53	−0.10	3.17	−1.40	3.30	+0.26	4.47	−0.70	3.91	+1.22	3.97
3,500	3.48	−0.31	2.35	−1.26	2.90	+0.56	2.71	−1.42	3.55	+1.35	3.24
4,000	2.66	−0.46	1.32	−1.47	2.11	+0.34	1.81	−1.62	3.70	+2.11	2.47
4,500	2.07	−0.45			1.59	+0.23					1.53
5,000	1.93	−0.43									1.13

* Naval Air Station.

THE WEATHER ELEMENTS

By P. C. DAY, In Charge of Division

PRESSURE AND WINDS

The most important feature of the weather was the marked absence of important cyclones and anticyclones. Pressure changes were frequent, but they were usually of small degree, and barometric depressions that in their early formation gave promise of developing into storms of wide extent frequently contracted their areas as they moved eastward, lost their important cyclonic characteristics, and failed to influence materially the weather along their paths.

In the absence of extensive cyclonic storms there was an important deficiency in precipitation over the central and eastern districts and drought more or less severe prevailed to a wide extent, though moderately cool weather over eastern and southern districts prevented as serious injury to growing vegetation as would have resulted had severe heat accompanied the dry weather as is frequently the case.

The precipitation from these poorly developed cyclones was mainly light, and usually coincident only over comparatively small areas, though locally heavy in a few instances.

Important precipitation occurred in the lower Mississippi Valley on the 2d and 3d. In southern Louisiana the falls were unusually heavy, particularly in the vicinity of New Orleans, where more than 9 inches fell in less than 10 hours and nearly 7 inches in about 3 hours. Precipitation on these dates covered much of the Mississippi Valley region, and during the following day extended over most eastern districts, though the falls were mainly light.

Rather extensive precipitation, though mostly light, overspread the Great Plains and western Mountain districts from the 7th to 9th, extending into the Mississippi Valley and southeastern States on the 10th and 11th, where the amounts were mainly larger, reaching an inch or more in portions of the middle Gulf States.

Widely scattered though mainly light precipitation occurred from the upper Mississippi Valley southeastward to the Atlantic coast from the 14th to 16th, and thence northeastward along the coast during the 16th and 17th, the amounts increasing to the northward and ranging up to 3 inches or more at points in New Jersey and southern New England.

More or less precipitation was rather general from the central valleys to the Atlantic coast about the 18th to 23d, attending the passage eastward of several small barometric depressions. During this period there were local heavy rains in the Florida Peninsula and adjacent Gulf and south Atlantic coast districts, and beneficial showers in the upper Mississippi Valley and Great Lakes region.

The latter part of the month had little precipitation except locally over northern districts between the Great Lakes and Rocky Mountains, but at the close there were rather extensive showers from the Missouri Valley southeastward to the lower Mississippi Valley and thence northeastward over the Ohio Valley and Middle Atlantic States.

Anticyclones were mainly unimportant to eastward of the Rocky Mountains, but usually reached their greatest development over a somewhat narrow area from the upper Lakes southeastward to the Florida Peninsula. West of the Rocky Mountains anticyclonic conditions were rather persistent over the Pacific Coast States and their influence extended generally over the Southwest.

The average pressure for the month was below normal from the Missouri Valley and adjacent portions of the Canadian Northwest southeastward to Florida, and over all districts in both the United States and Canada to eastward, the greatest deficiency occurring in the far northeastern portions.

From the Rocky Mountains and lower Mississippi Valley westward the average pressure was everywhere greater than normal, though the excess was not large over any area.

Compared with April the average pressure was lower over all districts in both the United States and Canada, save in the far West where there was a slight increase over the April values. Usually pressure is lower in May than in April over all parts of both countries save for a small area in eastern New England and the adjacent portions of the Maritime Provinces, but the decrease is usually small. During May, 1926, the average pressure over the interior portions of the United States was much lower than in the preceding month.

The distribution of pressure favored cool, northerly winds over the Northeastern States, but they were mainly from southerly points in the Gulf States and central valleys, and from westerly points near the Pacific coast.

Destructive winds were mainly local and no great damage or important loss of life was reported from that cause. Damage by hail, however, was extensive, as these storms occurred on many different dates and over widely separated districts, the greatest damage probably occurring in Texas, where from the 8th to 10th and on the 18th hail was widespread and caused damage estimated at nearly $3,000,000, mostly to growing crops. Extensive damage from hail was sustained in Sutter County, Calif., where the peach crop was injured to the extent of $250,000. Severe losses from hail and wind were sustained in portions of Kansas and Oklahoma. The details concerning severe storms will be found at the end of this section.

TEMPERATURE

The tendency toward lower than normal temperatures over eastern and southern districts, so persistent during the two months preceding, continued through much of May, though the area of decided coolness was far smaller than in the preceding months, being confined largely to the more northeastern and extreme southern districts. On the other hand, the unusual heat that has marked the weather over much of the western half of the country since January continued through May, the heated area extending into the central valleys, which had not been the case to any large extent during the two preceding months.

Day to day changes in temperatures were mainly small, important variations being confined chiefly to the more northern sections and occurring mostly during the first few days. The daily range in temperature, however, was frequently large, notably on the 1st near the western end of Lake Superior where there was a rise of 52° in a few hours. In general the daily range was large in many of the central-northern districts due to high percentage of clear sky, affording opportunity for the maximum insolation during the day and rapid cooling at night. At points in the upper Mississippi Valley the average daily range was the greatest of record for any month of the year.

There were but few instances of monthly means or extremes of temperature surpassing those in May of other years, though Sioux City, Iowa, had the warmest May in nearly 40 years, and at San Diego, Calif., it was the warmest May in more than 50 years save one, 1885. Maximum temperatures during the latter part of the month at several points in the Great Plains were the highest observed in May during 50 years or more.

In portions of California and the far Northwest the three months, March to May, inclusive, constitute the warmest similar period of record, and in much of the same area the average monthly temperatures have been in excess of the normal for the past 6 months.

The continued high temperature in portions of the Northwest since the first of the year is probably without precedent in that region both as to length of time with temperature nearly continuously above normal, and the extent of the departure. At Havre, Mont., of the 151 days from January 1 to May 31, only 23 days had temperature below normal, and the average excess for that period has been 9.4° per day. Of the 23 days with temperature below normal 15 occurred during a cool period from March 25 to April 8, inclusive; aside from this the temperature has been almost continuously above normal for the entire period.

The most important warm periods were mainly toward the end of the month, notably from the 26th to 28th in the Gulf States and portions of near-by areas, on the 29th in the Middle Plains and in the Southwest on the 30th and 31st. In portions of the Middle and North Atlantic States the maximum temperature occurred on the 2d, and in parts of the upper Mississippi Valley as early as the 1st.

The lowest temperatures were well scattered through the month, but mostly from the 3d to 5th in the eastern half of the country, about the 7th to 10th in the Southwest and on the 14th and 15th in the Middle Plains.

Temperatures below freezing were observed as far south as western North Carolina, in the mountains of Tennessee and Arkansas, and to the northern border of Oklahoma. In the Mountain States of the West, temperatures as low as 10° were reported from exposed points.

The average temperature continued below normal to a considerable degree over the Northeastern States, as has been the case since February inclusive, and it continued moderately cool in the South as was the case in March and April. In the far West temperature continued above the normal as has been the case since the first of the year and also in the upper Missouri Valley, which area has likewise been above normal for the greater part of the present year so far. In the central valleys the month was decidedly warm.

PRECIPITATION

As has been the case during most of the months of the present year to date, precipitation was widely deficient and particularly so over the interior, eastern and most southern districts, where a general lack of rain has persisted for several months, and conditions approaching severe drought were existing in many localities, particularly in the Southeastern States, where locally it was the driest May of record.

On the other hand, the rainfall was generous for the season in Arizona, New Mexico, and generally over Colorado, Utah, and Wyoming, where the warm season rainfall began unusually early. There were also some decidedly heavy falls locally in southern Louisiana, eastern Texas, near the Black Hills region of South Dakota, and in the far Northwest.

SNOWFALL

Light snow fell in northern New England on the 8th and 9th, the depths reaching as much as 2 inches locally in Maine. There was also snow over the upper Michigan peninsula and adjacent areas of Wisconsin, amounting to as much as 5 inches in extreme northern portions. Elsewhere there was little or no snow save in the western mountains. In Colorado snow was fairly heavy in the higher mountains, reaching a depth of 30 inches locally, and there were depths up to a foot or more at points in California. Otherwise the snowfall in the mountains was mainly light.

ICE IN THE GREAT LAKES

Owing to the continued cool weather over the Lake region the ice melted slowly, and due to westerly winds accumulated, as stated in April, to an unusual extent in the eastern end of Lake Erie. At Buffalo, N. Y., the conditions attending the opening of navigation were the worst ever known, and it was not until May 9 that navigation was finally opened, and this was accomplished only after laborious efforts on the part of the big steel freighters in breaking their way through the heavy ice fields.

RELATIVE HUMIDITY

The percentages of relative humidity were almost universally less than normally shown for May, only scattering stations reporting values above normal.

The deficiencies were particularly large over the eastern half of the country and moderately so over most western districts, though there was a moderate excess over portions of the far Southwest where rainy weather prevailed to a considerable extent.

SEVERE LOCAL HAIL AND WIND STORMS, MAY, 1926

The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the Annual Report of the Chief of Bureau.

Place	Date	Time	Width of path, yards [1]	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Beaver City, Nebr.	1		880		$750	Hail	Damage principally to early gardens	Official, U. S. Weather Bureau.
Howard County, Nebr. (northwest part of).	1	4:30 p. m.	3 mi.		500	do	Many early gardens ruined; windows broken. Path 20 miles.	Do.
Alva, Okla., and vicinity	2	do	8 mi.			Heavy hail	Severe damage to growing crops over path 16 miles long.	Do.
Custer County, Okla. (west part of).	2	7 p. m.	2,640		15,400	do	Crops injured	Do.
Milwaukee, Wis., and vicinity.	2	P. m.			1,000	Thundersquall	Plate glass windows broken; signs, awnings and etc., damaged.	Do.
Minnehaha District, Clarke County, Wash.	4	10:30 a. m.	50		3,000	Tornadic wind	A number of small buildings razed, others damaged. Many fruit trees injured. Path 2 miles long.	Do.
Bend, Calif.	4	5:30 p. m.	2,640		8,000	Wind	Young turkeys and chickens killed; other property damage.	Do.
Red Bluff, Calif. (north and east of).	4	6-9 p. m.				Hail	About 600 sheep lost due to exposure from storm.	Do.
Antelope Valley, Tehama County, Calif.	4	7:15 p. m.	5 mi.		10,000	Hail and rain	Crops beaten, roads washed, 1,100 sheep drowned; damage to fruit not estimated.	Do.
Miami, Fla. (near)	5	P. m.				do	Several small buildings under construction blown down.	Do.
Grady County, Okla. (southeast part of).	6	do	4 mi.		4,000	Hail	Crops injured	Do.
San Juan, P. R. (vicinity of)	6	8:19 p. m.		1		Thunderstorm and heavy hail.	Many paper-covered roofs damaged; trees and shrubs stripped, some broken or uprooted; a man killed by live wire.	Do.
Elgin, Tex.	7	A. m.	3,520		5,000	Hail	Crops and buildings damaged. Path 2 miles long.	Do.
Taylor, Tex.	7	do	5 mi.		30,000	do	Crops severely injured	Do.
Okmulgee, Okla. (3 miles north of).	7	1:30 p. m.	880		100,000	Tornado	Considerable property damage; slight injury to crops; 23 persons injured.	Do.
Sutter County, Calif.	7	2:30 p. m.	3 mi.		250,000	Hail	Extensive damage to peaches	Do.
Bokoshe, Okla. (2½ miles north of).	7	6 p. m.	880	3	56,400	Tornado and hail	Crop damage about $16,000; property considerable.	Do.
Shreveport, La. (25-50 miles south of).	7-8					Hail	Cotton and corn considerably damaged necessitating some replanting.	Do.
Boynton, Okla. (6 miles northeast of).	8	2:30 p. m.	100		6,500	Tornado	Some property damaged in oil field	Do.
Cimarron and Texas Counties, Okla.	8	2-3 p. m.				Hail	Crops damaged	Do.
Clarence, La. (near)	8	3 p. m.	440-1,760			do	Young crops severely injured	Do.
Remus, Okla.	8	do			1,000	Wind	Character of damage not reported	Do.
Garvin County, Okla. (south-central part of).	8	4 p. m.	4 mi.		100,000	Severe hail	Crop loss heavy; other damage about $25,000	Do.
Meade to Pratt County, Kans	8	5-8 p. m.	2-8 mi.		350,000	do	Damage chiefly to wheat over path 85 miles long.	Do.
Dallas, Tex., and vicinity	8	6 p. m.	1-15 mi.		875,000	do	Public utilities companies suffer heavy losses; much damage to crops, buildings, and other property.	Do.
Strong City to Cotton Wood Falls, Kans.	8	7 p. m.	5-8 mi.		3,000	do	Path short; damage principally to window glass and automobile tops.	Do.

[1] "Mi." signifies miles instead of yards.

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Brownville, Nebr	8	11 p. m.	3,520		15,000	Severe hail	Crops damaged over an area about 2 miles square.	Official, U. S. Weather Bureau.
Horatio, Ark	9	2 a. m.	2-4 mi.		50,000	Heavy hail	Serious crop damage	Do.
Piggott, Ark	9	10:30 a. m.	3 mi.		5,000	do	Crops injured; chickens killed	Do.
Scotland, Ark	9	12:30 p. m.	880-2,200			do	Gardens and cotton will have to be replanted	Do.
Charleston, Mo. (10 miles southwest of).	9	4 p. m.	1,760		60,000	Hail and thunderstorm.	Property and crop damage	Do.
Kaufman, Tex	9	8 p. m.			115,000	Heavy hail	Crop loss heavy; about $15,000 damage to property.	Do.
Ballard, Carlisle, and McCracken Counties, Ky. (parts of).	9				60,000	Heavy hail and wind.	Considerable property damage	Do.
New Castle (near) to Birmingham (near), Ala.	9				10,000	Severe hail	Buildings damaged	Do.
Western Tennessee	9				100,000	Severe hail and wind.	Buildings damaged; trees uprooted; strawberry and tomato as well as other crops severely injured.	Do.
Bulcher, Tex. (near)	10	5 a. m.				Tornado	Oil derrick wrecked; 1 person injured	Do.
Terre Haute, Ind	10	5-5:50 a. m.			2,000	Thunderstorm	Residence wrecked; telephones out of order	Do.
Love County, Okla. (western part of.)	10	6 a. m.	3,520		13,000	Heavy hail	Crops injured; minor property damage	Do.
Central, S. C	10	12 noon	6 mi.			Moderate hail	Damage on about 6,000 acres	Do.
Camden, Ark	10	1 p. m.			1,000	do	Orchards injured	Do.
Chestnut, La. (3 miles west of).	10	P. m.			100,000	Tornado	Seven homes demolished; 11 persons injured, 3 seriously.	Shreveport Journal (La.).
Georgia (central and northern parts).	10					Wind	Telephone and telegraph poles prostrated; shade and fruit trees blown down; small buildings and autos damaged.	Official, U. S. Weather Bureau.
Lincoln, Ill. (6 miles east of)	10				5,000	Thunder storm	Barn and contents burned; residence damaged	Do.
Grayson, Fanin, Lamar, Delta, Denton, and Smith Counties, Tex.	10				1,713,000	Heavy hail	Heavy crop and property damage; some damage by wind in Smith County; storms generally occurred in the morning and ranged from 3 to 10 miles wide to 30 miles long.	Do.
Montgomery and Albany, Ala.	10-11				1,000	Thunderstorm	Character of damage not reported	Do.
Judsonia, Ark. (8 miles north of).	11	2:30 p. m.	3,520		75,000	Heavy hail	Damage confined principally to strawberry crop.	Do.
Evening Shade, Ark	11	4 p. m.	880-1,760		1,000	do	Gardens, corn, and cotton injured	Do.
Greer County, Okla. (west part of).	11	4-6 p. m.	1-4 mi.			do	Heavy crop loss; path 20 miles long	Do.
Nida, Okla. (northwest of)	11	P. m.	1,760		35,000	do	Chief damage to crops	Do.
Aynor, S. C. (near)	11	do			1,000	Small tornado	Farm buildings damaged; some forest trees uprooted.	Do.
Maury-Hickman county line, Tenn.	11	do				Thunderstorm and hail.	Several large trees uprooted; a porch wrecked and a silo blown down.	Do.
Roane and Loudon Counties, Tenn.	11		3-4 mi.		150,000	Severe hail	Extensive damage to peach orchards; strawberry patch valued at $8,000 more or less a total loss; other crops injured.	Do.
Chesterfield, S. C. (near)	11-12		6 mi.		50,000	do	Young crops on about 6,000 acres damaged	Do.
Butler County, Kans. (north part of.)	13	2:30 p. m.	100		500	Tornado	Storm over sparsely settled rural section	Do.
Barber County, Kans. (south part of).	15	6 p. m.	440		8,000	do	Character of damage not reported	Do.
Grubbs, Ark	17	6 a. m.	2,640		2,000	Heavy hail and wind.	Corn and cotton beaten to ground; barn blown down, killing a horse.	Do.
Scotts Bluff County, Nebr. (west part of).	17	12:30-1 p. m.	3,520		3,500	Heavy hail	Alfalfa suffered considerably	Do.
Brinkman, Okla	17	1 p. m.	3,520		10,000	do	Damage chiefly to crops over path 4 miles long	Do.
Wauneta, Nebr	17	4:15 p. m.	170		2,000	Wind	Roof of church moved; bus loaded with children turned over; no one injured.	Do.
Beeville, Tex	17	5 p. m.	2,640		10,000	Hail	Crops and windows damaged; path 8 miles long	Do.
Sangamon and Christian Counties, Ill.	18	3 p. m.		1	3,000	Wind	Some property damage; three persons injured	Do.
Harvey, Ill	18	5 p. m.	50-100			Small tornado	Two residences and a number of small buildings demolished, many roofs damaged; scores of trees shattered or uprooted; automobiles crushed; telephone and power line poles leveled over path 2 miles long.	Do.
Roger Mills County, Okla. (south part of).	18	6-7 p. m.				Hail	Considerable crop damage	Do.
Evansville, Ind	18	8:50 p. m.				Wind	Minor damage to trees, insecure signs, awnings, etc.; green fruit blown off.	Do.
Lexington, Ky. (near)	18		3,520		15,000	Heavy hail	Damage over path 6 miles long	Do.
Maumee Valley, Ohio	18	P. m.				Wind	Damage chiefly to farm buildings, silos, etc	Do.
Piqua, Ohio (near)	18	do	440		10,000	Tornadic wind	Property damage reported; also loss of 5 head of cattle by lightning.	Do.
Sparta, Ill. (5 miles west of)	18				3,000	Thunderstorm	Barn struck by lightning	Do.
Wells County, Ind	18	P. m.	8 mi.	1	20,000	Wind, rain, and hail.	General damage resulted	Do.
Taylor, Knox, Haskell, and Clay Counties, Tex.	18	do			86,000	Hail	Crops, buildings, gardens, and trees damaged	Do.
Bluffton, Lafayette and Mauzy Counties, Ind.	18					Heavy hail	Considerable damage reported	Do.
Argo, Ill. (2 miles west of)	18			1		Wind	Plane crashed, killing air-mail flyer	Do.
Youngstown, Ohio	19	1 a. m.				Hail	Windows damaged; early gardens injured	Do.
Washington County, Md. (east-central part of).	19	3-4 p. m.	440-880		37,500	Heavy hail	Crops and fruit severely injured; gardens ruined; roofs damaged; auto tops pierced.	Do.
Plainview, Tex	19	6 p. m.	4 mi.		15,000	do	Crops and buildings damaged	Do.
New Castle County, Del. (north part of).	19	7-8 p. m.	6 mi.		50,000	do	Crops, greenhouses, auto tops, and roofs damaged.	Do.
Lafayette, Ind. (north of)	19		220-440		10,000	Tornadic wind	Character of damage not reported	Do.
Gretna, Nebr	20		1,760		2,000	Hail	Fruit and gardens injured	Do.
Springfield, Nebr	21	6 p. m.	4 mi.		3,000	Hail and rain	Gardens ruined and many fruit trees injured; corn flooded.	Do.
Fort Sumner, N. Mex	22				6,500	Hail	Extent of damage not reported	Do.
Buchanan, Cerro Gordo, Floyd, Iowa, Bremer, Jackson, Mitchell, Polk, and Worth Counties, Iowa.	24				14,800	Hail and wind	Damage principally by wind; only minor destruction by hail. Paths of storms ranged from 2 to 4 miles wide to 7 miles long.	Do. Do.
Warren Township, Lucas County, Iowa.	26	6 p. m.	6 mi.		1,000	Wind	Buildings damaged; path 6 miles	Do.
Wright Township, Wayne County, Iowa.	26	do	do		1,000	Hail and wind	do	Do.
Plainview, N. Mex	26					Wind	Much damage, character of which was not reported.	Do.
New Mexico (parts of east half).	26					Hail	Extent of damage not reported	Do.

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Raymond, Nebr.	27	3-6 p. m.				Hail and rain	Corn washed out; truck gardens and strawberries damaged by hail.	Official, U. S. Weather Bureau.
Newberry, S. C.	27	11 p. m.			18,000	Thunderstorm	Damage by lightning to cotton and cotton-mill equipment.	Do.
Rogers Mesa and Paonia, Colo.	28	1 p. m.	300		15,000	Heavy hail	Cherries, apricots, and possibly apples damaged.	Do.
Sedgwick County, Kans. (north part of).	28	9 p. m.	1,760		100,000	Severe hail	Growing wheat damaged, path 16 miles long	Do.
Fort Stockton, Tex.	29	5 p. m.	3,520		110,000	do	Extensive property and crop damage over path 10 miles long.	Do.
Carroll County, Ill.	29	6 p. m.			22,830	Hail	Storm covered three distinct areas. Residences and greenhouses damaged; cattle and hogs injured; crops beaten.	Do.
Keokuk, Iowa and north of	29	P. m.				Hail and wind	Wind damage in city to small light buildings; damage to grapes by hail.	Do.
Paonia, Colo.	30	2 p. m.			1,000	Hail	Injured cherries, apricots, and apples	Do.
Menifee County, Ky.	30				14,000	Electrical	Store destroyed	Do.
Sideview, Ky. (near)	30			1		do	House wrecked	Do.
Alex and Bradley, Okla.	30		2,640		[1] 20,000	Hail	Chief damage to crops	Do.
Do.	31		3 mi.			do	Damage included in that of the 30th	Do.
Terre Haute, Ind. (near)	31	1:28 p. m.		2		Thunderstorm	Two persons, a horse, and a dog killed by lightning.	Do.
Uniontown, Ark.	31	6 p. m.		1		Wind and electrical.	Several small buildings destroyed	Do.
Jefferson County, Okla. (central part of).	31	6-7 p. m.	4 mi.			Heavy hail	Considerable damage; no estimate obtainable; path 30 miles.	Do.
Dallas, Tex., and vicinity	31	9:20 p. m.				Thunderstorm	Wires damaged by lightning; other property by wind; 2 persons injured.	Do.
Marion County, Ind.	31		220		50,000	Tornadic wind	Considerable property damage	Do.
Princetown, Ohio (near)	31					Hail	All crops over narrow strip injured	Do.

[1] Includes damage at the same places on the 31st.

STORMS AND WEATHER WARNINGS

WASHINGTON FORECAST DISTRICT

Storm warnings were issued in connection with only two storms during the month. The first were displayed from Nantucket, Mass., to Eastport, Me., at 9:30 p. m. of the 8th, because of a storm of considerable intensity that advanced north-northeastward from the vicinity of Bermuda to latitude 40° N. and then north-northwestward to Nova Scotia and eastern Maine. The other warnings were ordered from Atlantic City, N. J., to Eastport, Me., in connection with a disturbance of moderate intensity that advanced northeastward along the coast during the 16th–17th. Several stations reported maximum wind velocities of from 34 to more than 40 m. p. h. from the northeast.

Small craft warnings were displayed on portions of the east Gulf coast on the 6th and 11th, and on parts of the Atlantic coast north of Cape Hatteras on the 3d and 23d.

Frost warnings, almost entirely for the area from Kentucky eastward and northeastward, were issued on the 3d, 4th, 9th, 11th, 15th, 20th, 22d, 23d, 24th, and 26th. No general frosts occurred over the areas for which frost was forecast.—*C. L. Mitchell.*

CHICAGO FORECAST DISTRICT

Marked contrasts in temperature took place throughout the forecast district during May, there being both warm and cool periods. The temperature, on the whole, averaged above normal, except over eastern upper Michigan and most of the lower Michigan peninsula. They averaged considerably above the seasonal normal in the Great Plains States, and the greatest excess was 7.8° in eastern South Dakota. Record-breaking maxima were registered at several stations on the Great Plains.

The rainfall throughout the district was below the monthly normal, except in a few small areas, and the deficiency in the Mississippi and lower Missouri valleys was considerable.

The principal features of the weather were the high temperature and the deficient precipitation in the western portion of the district. There was naturally less storm movement than usual.

The month opened with a disturbance of moderate intensity central over the Great Plains and a high pressure area in the North Pacific region. These areas moved eastward, so that by the morning of the 2d the disturbance had reached the Upper Lakes and the high pressure the Canadian Northwest. Storm warnings were ordered on this morning for the Upper Lakes and small craft warnings for the Lower Lakes; and frost warnings for the Northwestern States and thence eastward across the upper Mississippi Valley. Frost warnings were issued on the 3d for the Upper Lake region and adjoining sections. The storm warnings were only partly verified, but frosts occurred as predicted.

On the morning of the 10th a LOW of considerable intensity, which had moved eastward from the Great Plains, was centered in the Ohio Valley, with a cold HIGH beyond the northern Rockies. Frost warnings were issued from the 10th to the 14th for the Northwestern States and eastward across the Upper Lake Region and adjoining sections; and the ensuing frosts were more or less general.

On the 18th general thunderstorms occurred over middle districts, accompanying the passage of a depression apparently of moderate energy. In the afternoon of that day a small tornado passed through Harvey, Ill., 22 miles south of Chicago. There was no loss of life, but damage to property amounted to about $200,000. Showers and thunderstorms were predicted for the area in which the tornado occurred.

On the 19th the above-mentioned depression had moved northeastward to the Central Lakes Region and increased considerably in energy. A high-pressure area accompanied by comparatively low temperature was central over the Great Plains. Frost warnings were issued on that day for the Upper Lakes Region and adjoining areas; and frosts were reported generally from that area on the following morning.

On the night of the 20th storm warnings were ordered for all upper lakes stations, and on the morning of the 21st for the lower lakes, as a storm approached from the west. Warnings were continued on the Lower Lakes on the 22d, as the storm passed away very slowly down the St. Lawrence Valley. The warnings were partly verified, chiefly on Lakes Michigan and Huron.

Small-craft warnings were issued during the month for minor disturbances on the Great Lakes; and frost warnings for a few days during the latter half of the month for cranberry marshes in Wisconsin.

The special fire-weather forecast service for northern Michigan was resumed on the 18th; and fruit-spray forecast service for Door County, Wis., on the 4th. The fruit-spray forecast service was extended in lower Michigan on May 20 to include the Ann Arbor district; and the service for the southern portions of Illinois and Indiana, which was begun in April, was continued throughout the month.—*H. J. Cox.*

NEW ORLEANS FORECAST DISTRICT

Moderate weather prevailed over most of the district except that unusually heavy rainfall occurred locally. Small-craft warnings were issued for the Louisiana coast on one date and for the western portion of the Texas coast on two dates. No storm warnings were issued and no general storm occurred without warning. Frost was forecast for exposed localities in the northeastern portion of the district on the 15th; frost occurred in widely scattered localities. No general occurrence of frost without warnings was reported.—*I. M. Cline.*

DENVER FORECAST DISTRICT

Low pressures, attended by frequent showers and thunderstorms, with temperatures generally above normal, except in New Mexico, prevailed in southwestern Canada and most of the Rocky Mountain Region during the greater part of the month. From the 8th to the 14th, however, a HIGH from the north Pacific coast drifted slowly eastward and southeastward to the Plains States, and occasional frosts occurred in the northern and eastern portions of the district. Another HIGH advanced eastward on the 30th and frosts were reported from western Montana and northwestern Wyoming on the morning of the 31st.

Frost warnings, which were generally verified by the occurrence of frost or frost temperatures, were issued on the morning of the 1st for Montana and daily for some portion of the district during the period from the 7th to the 15th. Warnings for the higher valleys of western Colorado and the higher elevations of southern Utah were also distributed on the 25th and for the higher western valleys and extreme north-central Colorado and for Wyoming on the 31st.

At the request of the forest supervisor at Missoula, Mont., fire-weather forecasts for western Montana were begun on the 5th and continued throughout the remainder of the month. A forecast of strong winds, mostly westerly, was issued for New Mexico and Arizona on the 24th. A maximum velocity of 48 miles an hour from the south occurred at Albuquerque during the day of the 24th and again during the night of the 24th–25th, and a velocity of 40 miles an hour from the southwest was reported from the same station on the evening of the 25th.—*J. M. Sherier.*

SAN FRANCISCO FORECAST DISTRICT

The weather charts during the month of May showed rather unusual pressure formations for that month. Low pressure was persistent over the Aleutian Islands and the Gulf of Alaska and the HIGH, normally found off the California coast, was neither of its usual geographic magnitude nor was the pressure normal over the ocean where this semipermanent HIGH is charted. Semidaily interpolated pressures for the intersection of north parallel of 32° and west meridian of 140° show that the pressure was materially below an assumed normal of 30.30 inches until after the 22d, when a rise to above normal pressure set in; thereafter the readings were above normal. This pressure situation was attended by frequent showers in Washington and Oregon, Idaho, and Nevada and by generally fair and warm weather in California. No storms of marked intensity visited the coastal regions of this forecast district. It was necessary to issue many forecasts of showers for the Pacific Northwestern States. Frost warnings were disseminated on a number of days in all States except California. The fire hazard in the forested areas of California became acute during the latter part of the month and necessitated warnings of low humidity and high temperature, which were issued well in advance of their occurrence. The month was the third successive one of which the average temperature at San Francisco exceeded those previously recorded during a period of more than 50 years.—*E. H Bowie.*

RIVERS AND FLOODS

By H. C. FRANKENFIELD

No rises of importance occurred during May. Virtually all cases in which the flood stage was exceeded represent continuations of floods already reported upon in the April number of this REVIEW.

A new river district with headquarters at Brownsville, Tex., will be established on June 1, 1926, comprising the drainage area of the Rio Grande below El Paso, Tex. This portion of the river was a part of the San Antonio, Tex., district, but the increasing importance of agricultural interests along the lower Rio Grande require special service that can best be supplied from Brownsville.

Flood stages during month of May, 1926

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC DRAINAGE					
Connecticut:	*Feet*			*Feet*	
White River Junction, Vt.	15	3	8	18.9	May 6.
Hartford, Conn.	16	[1]	8	20.8	Apr. 27.
MISSISSIPPI DRAINAGE					
Tippecanoe: Norway, Ind.	6	5	6	6.3	May 5.
		10	11	6.3	May 11.
Illinois:					
Peru, Ill.	14	[1]	6	19.4	Apr. 12–13.
Henry, Ill.	10	[1]	4	13.8	Apr. 14.
Havana, Ill.	14	[1]	8	17.6	Apr. 16–18.
Beardstown, Ill.	14	[1]	11	19.6	Apr. 17–18.
Pearl, Ill.	12	[1]	7	15.9	Apr. 15–19.
Canadian: Logan, N. Mex.	4			5.0	May 14.
				5.0	May 19.
				5.0	May 23.
				6.6	May 27.
Sulphur: Ringo Crossing, Tex.	20	9	9	21.3	May 9.
WEST GULF DRAINAGE					
Trinity:					
Dallas, Tex.	25	21	21	27.8	May 21.
Trinidad, Tex.	28	[1]	1	34.1	Apr. 28.
Liberty, Tex.	25	[1]	12	27.4	Apr. 30–May 1.
Rio Grande: San Marcial, N. Mex.	2	[1]	[2]	4.5	May 27–28.
PACIFIC DRAINAGE					
Colorado: Parker, Ariz.	7	[1]	[2]	9.5	May 31.
Gunnison: Delta, Colo.	9	6	6	9.3	May 6.
		22	28	9.8	May 25.
		31	31	9.0	May 31.

[1] Continued from last month. [2] Continued at end of month.

MEAN LAKE LEVELS DURING MAY, 1926

By UNITED STATES LAKE SURVEY

[Detroit, Mich., June 5, 1926]

The following data are reported in the Notice to Mariners of the above date:

Data	Lakes [1]			
	Superior	Michigan and Huron	Erie	Ontario
Mean level during May, 1926:	*Feet*	*Feet*	*Feet*	*Feet*
Above mean sea level at New York	600.18	578.14	571.17	245.37
Above or below—				
Mean stage of April, 1926	+0.06	+0.32	+0.37	+0.45
Mean stage of May, 1925	+0.26	−0.28	−0.14	−0.28
Average stage for May, last 10 years	−1.73	−2.22	−1.34	−1.05
Highest recorded May stage	−2.87	−5.38	−3.25	−3.58
Lowest recorded May stage	−0.64	−0.28	−0.14	+0.41
Average departure (since 1860) of the May level from the April level	+0.31	+0.31	+0.34	+0.34

[1] Lake St. Clair's level: In May, 1926, 573.61 feet.

EFFECT OF WEATHER ON CROPS AND FARMING OPERATIONS MAY, 1926

By J. B. KINCER

General summary.—During the early part of the month the prevailing generally fair and sunshiny weather was favorable for outdoor operations in most sections of the country, but it continued too cool for growth of early crops in the East, and germination was mostly slow. The soil was needing moisture in the Central-Northern States, and it had become too dry in the Southeast, but rather widespread showers, beginning about the 7th, were very beneficial in the former area. During the first half of the month there was some interruption to field work by too much rain in the Southwest, but thereafter better conditions prevailed in that section.

During the latter part of the month the need of moisture became rather urgent in much of the interior of the country, including the southern portions of Indiana and Illinois, much of Kentucky and Tennessee, parts of Ohio, and most sections of the trans-Mississippi States from Missouri and south-central Oklahoma northward; at the same time rains in the Lake region materially improved agricultural conditions. In the interior of the Southeastern States, particularly in the western Carolinas and some adjoining sections, the drought became severe and was critical in some districts. In the Southwest good growing weather prevailed, while showers improved conditions over most of the Spring Wheat Belt. No noteworthy damage from frost occurred during the month.

Small grains.—In general the weather was favorable for the winter wheat crop, except in the west-central Great Plains, where there was a marked deficiency in moisture. Rainfall was insufficient in parts of the Ohio Valley States, but in general the crop made satisfactory development, except in western and northwestern Kansas and parts of Nebraska, where the drought was damaging. In the Southwest wheat made good to excellent growth by reason of the prevailing favorable weather. In the Spring Wheat Belt, conditions were only fairly favorable, as moisture was insufficient during most of the time in many places, although rainfall about the close of the first week, and again near the end of the month, was beneficial, particularly in the Red River Valley. At the close of the month this crop was mainly in fair to good condition, except that it was mostly poor in Minnesota, and where rain was needed in some other localities. Oats were heading short generally because of scanty moisture.

Corn.—With favorable weather for field operations, corn planting made generally good progress, and, by the 20th, this work was well along to nearly the northern limits of the belt in the trans-Mississippi States, and much had been seeded in the Ohio Valley. There was some delay to cultivation by wet weather in parts of the Southwest. In the western portion of the belt the weather was fairly favorable for germination, and stands were mostly satisfactory, though only fair in Iowa; in the eastern portion it was rather too cool for good germination, and moisture was needed in some sections. The crop made very good progress in the Southwest.

Cotton.—During the first part of May cool nights made conditions generally unfavorable for germination of cotton, which resulted in uneven stands in many places, but field work made good progress. The warmer weather the latter part of the month was favorable and cotton made fair to very good advance, except in sections of the Carolinas and northern Georgia where severe drought prevailed. Planting and replanting was mostly completed in the Southwest, with progress of the crop very good, but its condition spotted. In the southern portion of the belt, early plants were forming squares freely at the close of the month, but in the North they were small and late, with condition decidedly unfavorable in the interior of the Southeast where the warmer weather intensified the drought.

Miscellaneous crops.—Pastures and meadows made rather slow progress during the month in most of the eastern half of the country, because of cool weather and, in many places, deficient rainfall. In the Southwest the range continued in good condition, but rain was needed in much of the Plateau section. The latter part of the period was more favorable for planting late potatoes in northern districts, but in the Southeast this crop suffered for moisture. Truck and minor crops were benefited by showers the latter part of the month in the interior Eastern States, and they did well in the Southwest, but were slow in the Southeast. Sugar beets grew nicely, and in the lower Mississippi Valley cane made excellent progress.

CLIMATOLOGICAL TABLES

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, May, 1926

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	70.4	−0.9	2 stations	99	[2] 27	Riverton	39	5	2.99	−0.98	Millry	5.40	Winfield	1.35
Arizona	66.1	−0.2	Gila Bend	110	31	4 stations	23	[2] 9	0.59	+0.31	Snowflake	2.31	12 stations	0.00
Arkansas	69.7	+0.7	Newport	107	29	Dutton	29	15	2.42	−2.60	McGehee	6.18	Osceola	0.48
California	63.7	+3.1	Greenland Ranch	114	31	Ellery Lake	11	8	0.63	−0.47	Crescent City	6.85	34 stations	0.00
Colorado	52.7	+1.4	2 stations	96	[2] 23	Lake Moraine	10	7	2.23	+0.38	Haxtum	4.95	Silver Lake	0.10
Florida	74.6	−0.9	Fernandina	99	27	3 stations	46	[2] 1	2.76	−1.74	Chapman Field Garden.	8.00	Fernandina	0.13
Georgia	71.3	−0.3	Lisbon	103	26	2 stations	40	[2] 7	1.69	−1.81	Brooklet	5.79	Washington	0.17
Idaho	54.3	+1.8	Chattins Flat	95	20	Atlanta	14	[2] 24	1.36	−0.28	Cuprum	4.73	2 stations	0.10
Illinois	64.8	+2.2	Carbondale	98	29	Waukegan	27	4	2.24	−1.78	Springfield	4.54	Golconda	0.55
Indiana	63.4	+1.2	Jeffersonville	99	26	Plymouth	20	4	2.89	−1.12	Crawfordsville	6.79	Princeton	0.20
Iowa	64.5	+4.3	6 stations	97	[2] 1	Milford	25	3	2.76	−1.85	Britt	6.83	Harlan	0.52
Kansas	66.3	+3.0	Fort Scott	99	29	Oberlin	30	14	2.20	−1.67	Grenola	5.29	Leavenworth	0.61
Kentucky	66.2	+0.6	Murray	101	27	Farmers	31	5	2.36	−1.61	Hazard	5.62	Cloverport	0.17
Louisiana	72.3	−1.5	Lake Providence	99	[2] 26	Lake Providence	40	[2] 5	5.39	+1.06	New Orleans	13.66	Colfax	2.15
Maryland-Delaware	62.0	−0.6	Clear Spring, Md	94	7	Maryland Line, Md	25	5	2.08	−1.51	Wilmington, Del	3.51	Western Port, Md	0.19
Michigan	54.0	+0.2	Bangor	96	31	Houghton Lake	12	4	2.43	−0.88	South Haven	5.31	Saint James	0.42
Minnesota	59.4	+4.8	4 stations	97	[2] 5	2 stations	12	3	1.99	−1.29	Baudette	4.66	Centerville	0.42
Mississippi	71.1	−0.4	Kosciusko	102	28	2 stations	40	[2] 5	3.81	−0.84	Magnolia	8.17	Holly Springs	0.65
Missouri	67.0	+2.4	Marshall	100	29	3 stations	32	15	2.73	−1.97	Dean	7.82	Kidder	0.40
Montana	54.3	+2.8	2 stations	95	24	Conway's Ranch	19	31	1.59	−0.56	Livingston	6.86	Lothair	0.15
Nebraska	64.1	+5.1	3 stations	100	[2] 22	Gordon	21	14	2.78	−0.77	Schuyler	6.28	North Platte	0.91
Nevada	58.4	+2.3	Logandale	106	31	Rye Patch	18	[2] 9	0.45	−0.44	Orovada	1.64	2 stations	0.00
New England	52.6	−1.9	Cavendish, Vt	89	2	2 stations	18	5	1.95	−1.46	Block Island, R. I.	4.44	Plymouth, N. H.	0.57
New Jersey	59.1	−1.2	2 stations	90	[2] 2	3 stations	26	5	2.58	−1.00	Tuckerton	4.52	Woodcliff Lake	1.08
New Mexico	57.5	−1.1	2 stations	99	[2] 21	Cimarron	15	8	2.41	+1.14	Amistad	7.91	Rodeo	T.
New York	54.0	−1.8	Ohioville	89	17	5 stations	21	[2] 4	1.68	−1.86	Mount Hope	3.20	Lauterbrunnen	0.06
North Carolina	66.3	−0.1	Rockingham	102	26	Mount Mitchell	26	16	1.67	−2.46	Banners Elk	4.46	Enfield	0.16
North Dakota	58.5	+5.9	Edgeley	105	4	2 stations	10	3	2.18	−0.37	Mott	4.02	Towner	0.43
Ohio	60.5	−0.1	2 stations	93	8	Canfield	19	13	2.51	−1.22	Mount Healthy	6.48	North Bass Island	0.35
Oklahoma	69.2	+1.6	2 stations	99	[2] 29	Smithville	32	15	3.06	−1.60	Antlers	6.42	Fort Reno	0.79
Oregon	55.5	+1.5	3 stations	91	[2] 12	Fremont	10	14	2.07	+0.15	Classic Lake	10.08	Klamath Falls	0.13
Pennsylvania	58.8	−0.7	Carlisle	95	7	West Bingham	18	5	1.78	−2.21	Grove City	5.52	Wellsboro	0.62
South Carolina	70.6	−0.4	2 stations	103	26	Caesars Head	38	16	1.06	−2.51	Garnett	3.54	Spartanburg	T.
South Dakota	62.4	+6.9	Kennebec	105	[2] 23	3 stations	17	3	2.71	−0.39	Rapid City	8.07	Redfield	1.01
Tennessee	67.2	+0.4	4 stations	99	[2] 25	Rugby	32	5	2.90	−1.32	Madison	7.90	Bolivar	0.78
Texas	72.1	−1.0	Big Spring	105	21	2 stations	35	[2] 14	3.37	−0.29	McKinney	9.61	Clint	0.47
Utah	56.9	+2.0	2 stations	100	[2] 30	Panguitch	17	10	1.53	+0.21	Silver Lake	4.25	Panguitch	0.00
Virginia	64.1	+0.0	Woodstock	95	2	Burkes Garden	24	5	2.26	−1.73	Dante	4.98	Callaville	0.38
Washington	55.1	+0.5	Wahluke	92	13	Paradise Inn	21	9	2.41	+0.43	Quinault	12.64	3 stations	T.
West Virginia	61.2	−0.7	Moorefield	94	2	Marlinton	24	5	2.50	−1.51	Beckley	4.65	Piedmont	0.07
Wisconsin	56.9	+2.1	Grantsburg	93	1	Rhinelander	19	3	3.72	−0.12	Hancock	8.19	Grantsburg	1.38
Wyoming	52.3	+3.2	2 stations	95	23	2 stations	12	[2] 11	2.38	+0.37	Knowles	5.40	Shoshone Dam	0.46
Alaska (April)	38.1	+5.3	Hydaburg	66	[2] 15	Barrow	−22	24	4.89	+1.08	Latouche	20.92	Fort Yukon	0.00
Hawaii	72.9	+1.1	Mana Pump	93	23	Kailuli	50	10	2.98	−3.18	Kawainui (upper)	15.01	6 stations	0.00
Porto Rico	78.1	+0.9	2 stations	98	20	Toro Negro	52	14	5.26	−1.30	San Sebastian	12.03	Mona Island	0.27

[1] For description of tables and charts, see REVIEW, January, 1926, p. 32.

[2] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, May, 1926*

District and station	Elevation of instruments			Pressure			Temperature of the air												Precipitation			Wind										
	Barometer above sea level	Thermometer above ground	Anemometer above ground	Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷ 2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Total	Departure from normal	Days with 0.01, or more	Total movement	Prevailing direction	Maximum velocity: Miles per hour	Maximum velocity: Direction	Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
New England							52.9	−1.7										70	2.32	−1.0										4.9		
Eastport	76	67	85	29.73	29.81	−.15	45.5	−2.2	68	15	53	32	9	38	31	43	40	83	1.92	−1.9	11	7,152	s.	36	nw.	8	4	10	17	7.1	1.0	0.0
Greenville, Me.	1,070	6		28.68	29.85		47.0		75	3	58	28	5	36	43				1.69		11		nw.	28		20	6	6	19		2.0	0.0
Portland, Me.	103	82	117	29.74	29.86	−.11	51.8	−1.5	76	18	60	35	5	44	29	46	39	66	2.16	−1.5	12	6,903	nw.	34	nw.	18	14	7	10	5.1	T.	0.0
Concord	289	70	79	29.54	29.85	−.13	54.2	−0.1	86	3	66	31	5	42	52				1.06	−2.2	10	4,874	nw.	28	sw.	3	10	13	8	5.1	0.0	0.0
Burlington	403	11	48	29.45	29.89	−.08	51.4	−5.1	80	2	62	29	5	41	34				1.28	−1.6	10	7,190	n.	35	s.	22	6	8	17	6.6	0.5	0.0
Northfield	876	12	60	28.93	29.89	−.08	48.7	−4.1	81	2	62	24	5	36	51	44	37	65	1.17	−1.6	8	5,783	n.	30	sw.	2	2	17	12	6.8	T.	0.0
Boston	125	115	188	29.72	29.86	−.12	56.0	−1.1	84	3	64	41	5	48	31	49	42	62	3.31	−0.2	10	7,402	w.	33	s.	21	14	9	8	4.3	0.0	0.0
Nantucket	12	14	90	29.85	29.86	−.13	52.0	−0.3	72	18	58	41	5	46	23	47	44	80	3.93	+1.3	13	10,985	sw.	38	sw.	24	13	10	8	4.8	0.0	0.0
Block Island	26	11	46	29.83	29.86	−.13	52.5	−0.3	71	18	59	40	4	46	21	47	44	77	4.44	+0.7	8	10,872	sw.	44	nw.	9	16	9	6	3.7	0.0	0.0
Providence	160	215	251	29.69	29.86	−.12	56.1	−2.4	80	18	66	37	5	46	31	48	40	60	2.48	−1.0	9	10,009	nw.	46	nw.	12	16	8	7	4.0	0.0	0.0
Hartford	159	122		29.70	29.87	−.11	57.0	−0.5	81	18	68	36	4	46	33				2.24	−1.3	11		s.				17	9	5	3.7	0.0	0.0
New Haven	106	74	153	29.76	29.88	−.11	56.6	−1.3	83	18	66	38	5	47	29	50	43	64	1.56	−2.1	10	6,798	s.	32	n.	17	22	5	4	2.9	0.0	0.0
Middle Atlantic States							61.6	−0.4										60	2.18	−1.3										4.4		
Albany	97	102	115	29.77	29.87	−.11	57.1	−2.2	81	17	68	34	4	40	46	49	42	60	0.80	−2.2	10	5,927	nw.	33	s.	21	14	12	5	4.4	0.0	0.0
Binghamton	871	10	84	28.99	29.92	−.06	55.3	−2.1	83	2	68	28	5	42	40				1.50	−1.6	5	4,420	nw.	34	sw.	2	13	8	10	5.2	T.	0.0
New York	314	414	454	29.55	29.88	−.11	58.5	−2.1	80	18	67	39	4	50	26	50	42	59	2.45	−0.7	10	12,492	nw.	50	nw.	8	15	11	5	4.3	0.0	0.0
Harrisburg	374	94	104	29.51	29.90	−.08	62.4	+0.6	85	2	74	37	4	51	35	51	41	50	1.63	−2.0	7	5,576	nw.	36	nw.	17	12	13	6	4.7	0.0	0.0
Philadelphia	114	123	190	29.78	29.91	−.08	63.0	+0.1	85	2	73	42	4	53	34	53	46	58	2.31	−0.9	10	7,222	sw.	30	sw.	15	14	11	6	4.5	0.0	0.0
Reading	325	81	98	29.55	29.89		61.5		88	2	73	38	5	50	38	53	46	59	2.07	−1.3	9	4,180	nw.	22	n.	11	15	13	3	4.1	0.0	0.0
Scranton	805	111	119	29.05	29.90	−.08	57.9	−1.5	85	2	70	32	4	46	38	48	40	54	1.66	−1.8	4	5,502	nw.	28	w.	3	9	10	12	5.9	0.0	0.0
Atlantic City	52	37	172	29.84	29.90	−.08	58.6	+0.5	82	18	66	40	5	51	28	52	48	72	3.75	+0.8	8	12,534	s.	48	w.	1	19	10	2	3.0	0.0	0.0
Cape May	17	13	49	29.91	29.93	−.06	61.5	−2.9	84	18	69	41	5	54	25	54	48	67	3.75	+0.8	10	6,463	s.				8	22	1		0.0	0.0
Sandy Hook	22	10	55	29.86	29.88		57.4		80	18	65	41	4	50	24	51	45	67	2.32		10	10,560	nw.	43	n.	8	14	13	4	3.9	0.0	0.0
Trenton	190	159	183	29.68	29.88		60.6		86	2	72	37	5	49	39	52	45	61	3.00	−0.5	9	6,765	nw.	42	nw.	19	15	11	5	4.2	0.0	0.0
Baltimore	123	100	113	29.77	29.90	−.09	64.5	+0.1	87	18	75	43	4	54	32	55	47	55	2.60	−1.0	9	4,324	nw.	19	s.	30	18	9	4	3.9	0.0	0.0
Washington	112	62	85	29.78	29.90	−.10	64.3	+0.6	88	2	76	39	5	52	38	54	46	56	2.22	−1.6	7	4,482	nw.	33	nw.	3	14	12	5	4.6	0.0	0.0
Cape Henry	18	8	54	29.88	29.90		63.0		91	2	71	41	6	55	34	56	52	70	2.33	−1.7	9	8,844	se.	52	nw.	16	18	7	6	3.8	0.0	0.0
Lynchburg	681	153	188	29.18	29.91	−.09	66.4	−0.9	93	8	79	40	5	53	43	55	48	55	0.44	−3.6	7	5,205	w.	42	sw.	15	13	12	6	4.9	0.0	0.0
Norfolk	91	170	205	29.82	29.92	−.08	65.6	−0.6	89	1	75	45	6	56	33	55	49	63	1.89	−2.2	10	8,979	ne.	42	s.	3	16	8	7	4.3	0.0	0.0
Richmond	144	11	52	29.76	29.92	−.07	65.7	−0.8	91	2	78	43	5	53	40	56	49	60	1.59	−2.3	10	5,532	ne.	44	nw.	10	17	11	3	3.7	0.0	0.0
Wytheville	2,304	49	55	27.59	29.92	−.07	61.2	−0.2	85	26	73	33	5	49	30	52	46	62	3.02	−0.9	8	4,811	w.	28	nw.	10	13	12	6	4.9	0.0	0.0
South Atlantic States							70.1	−0.1										64	1.80	−2.0										3.8		
Asheville	2,253	70	84	27.64	29.95	−.04	63.0	+0.4	86	25	75	38	5	51	40	53	47	63	2.37	−1.2	14	5,165	nw.	36	n.	16	15	13	3	3.9	0.0	0.0
Charlotte	779	55	62	29.11	29.93	−.06	69.9	+1.0	96	26	82	46	5	58	35	59	52	60	2.40	−1.5	9	3,171	sw.	23	w.	9	15	6	10	4.2	0.0	0.0
Hatteras	11	11	50	29.91	29.92	−.09	66.3	−2.4	81	25	72	52	4	60	21	61	58	78	1.91	−2.2	8	11,621	sw.	50	nw.	10	18	6	7	3.8	0.0	0.0
Raleigh	376	103	110	29.53	29.92	−.07	68.2	−0.3	93	26	80	43	5	56	36	57	50	58	0.35	−4.5	7	5,976	sw.	34	w.	15	17	5	9	4.5	0.0	0.0
Wilmington	78	81	91	29.86	29.94	−.07	68.8	−2.0	93	25	80	45	5	58	30	61	57	73	3.37	−0.7	11	5,988	sw.	28	sw.	19	18	8	5	3.5	0.0	0.0
Charleston	48	11	92	29.91	29.96	−.05	72.6	−0.1	95	27	82	53	16	64	26	64	61	73	2.33	−1.1	8	7,884	sw.	31	w.	15	18	7	6	3.7	0.0	0.0
Columbia, S. C.	351	41	57	29.57	29.94	−.06	72.6	+0.7	100	26	84	50	6	61	31	59	50	52	0.60	−2.6	6	5,375	sw.	32	w.	15	18	10	3	3.3	0.0	0.0
Due West	711	10	55	29.22	29.98		69.7		98	26	83	46	16	56	38				0.49		7	7,026	sw.	39	n.	27	15	11	5	3.6	0.0	0.0
Greenville, S. C.	1,039	139	146	28.85	29.93		69.7	+2.5	96	26	82	47	16	58	36	56	46	49	0.25		4	7,137	sw.	40	w.	9	16	11	4	3.9	0.0	0.0
Augusta	182	62	77	29.75	29.94	−.05	72.7	+0.3	100	26	85	51	6	60	35	63	57	61	0.37	−2.9	5	4,229	s.	33	w.	10	15	12	4	3.6	0.0	0.0
Savannah	65	150	194	29.89	29.96	−.04	73.1	−0.3	98	26	83	53	16	63	30	64	59	69	2.67	−0.3	6	9,273	w.	52	nw.	10	19	8	4	3.3	0.0	0.0
Jacksonville	43	209	245	29.93	29.98	−.02	73.8	−1.2	94	27	82	55	16	66	24	65	61	70	1.66	−2.6	4	9,084	sw.	45	w.	20	14	7	10	4.8	0.0	0.0
Florida Peninsula							77.0	−1.0										74	4.03	−0.2										5.8		
Key West	22	10	64	29.95	29.97	.00	78.7	−0.4	90	12	84	68	22	73	16	72	70	77	5.75	+2.4	13	6,589	e.	40	w.	13	9	6	16	6.2	0.0	0.0
Miami	25	71	79	29.97	30.00		76.8	−1.8	89	9	83	59	17	71	21	70	67	73	4.63	−1.8	14	4,458	e.	20	nw.	16	5	8	18	6.9	0.0	0.0
Tampa	35	70	87	29.94	29.98	−.01	75.4	−0.9	90	24	84	60	6	67	22	68	64	73	1.70	−1.2	8	4,568	e.	34	ne.	29	9	15	7	5.0	0.0	0.0
Titusville	44	5		29.94	29.99		75.5		95	10	87	54	16	64	32				1.26		8		w.				12	7	12	5.1	0.0	0.0
East Gulf States							71.5	−1.0										67	3.31	−0.2										4.3		
Atlanta	1,173	190	216	28.75	29.97	−.02	70.0	+0.1	92	25	80	48	15	60	28	58	50	56	0.89	−2.2	7	8,044	nw.	60	nw.	10	12	8	11	4.8	0.0	0.0
Macon	370	78	87	29.57	29.96	−.03	71.0	−1.3	97	26	83	50	1	59	38	60	52	55	0.69	−2.2	6	4,334	sw.	33	nw.	10	15	9	7	4.1	0.0	0.0
Thomasville	273	49	58	29.69	29.98	−.01	72.9	−1.1	96	26	84	52	16	62	29	63	57	66	2.69	−1.3	5	3,578	sw.	20	sw.	11	13	9	9	4.7	0.0	0.0
Apalachicola	36	42	49	29.95	29.99		72.4		89	28	79	57	16	66	22	67	64	77	1.21		5	5,744	w.	30	n.	26	18	9	4	3.5	0.0	0.0
Pensacola	56	149	185	29.92	29.99	.00	72.0	−1.9	87	23	77	57	16	67	20	66	63	76	2.75	+0.1	6	9,379	s.	48	se.	11	14	9	8	4.8	0.0	0.0
Anniston	741	9	57	29.21	30.00	+.01	68.6	+0.2	94	27	82	42	4	55	43				1.91	−1.2	9	3,332	w.	30	nw.	10	14	15	2	3.8	0.0	0.0
Birmingham	700	11	48	29.23	29.99	+.01	69.6	−1.5	93	27	81	48	5	58	36	59	53	62	4.31	+1.2	12	4,418	s.	33	nw.	10	15	8	8	4.3	0.0	0.0
Mobile	57	125	161	29.92	29.98	−.01	72.8	−1.6	91	26	81	56	16	65	28	65	61	72	1.77	−2.2	7	7,216	sw.	49	se.	11	11	14	6	4.6	0.0	0.0
Montgomery	223	100	112	29.74	29.00	.00	72.2	−1.2	94	26	82	51	16	62	30	62	55	61	2.50	−1.3	10	4,629	w.	36	nw.	10	15	10	6	4.0	0.0	0.0
Corinth	469	6					70.2		96	28	83	43	5	57	42				1.88		9		se.				10	19	2		0.0	0.0
Meridian	375	87	95	29.58	29.97	−.01	70.6	−0.7	92	28	82	48	5	60	35	62	57	67	2.43	−1.5	8	3,805	sw.	23	se.	6	12	16	3	4.0	0.0	0.0
Vicksburg	247	65	73	29.71	29.98	+.01	72.0	−0.9	93	28	82	50	15	62	25	62	57	67	2.79	−1.5	8	4,777	s.	32	se.	10	13	12	6	4.4	0.0	0.0
New Orleans	53	76	84	29.92	29.97	.00	74.8	−0.6	90	25	82	58	16	67	23	67	64	74	13.66	+9.8	7	4,369	se.	32	ne.	11	11	14	6	4.4	0.0	0.0
West Gulf States							72.7	−0.7										73	4.17	+0.1										4.7		
Shreveport	249	77	93	29.68	29.95	.00	72.8	−0.8	95	29	83	48	15	63	27	64	60	69	3.61	−0.6	9	5,034	se.	25	nw.	31	15	10	6	4.0	0.0	0.0
Bentonville	1,303	11	44				67.2	+0.8	92	29	79	41	15	56	32				2.61		9	4,029	s.	22	se.	6	19	6	6		0.0	0.0
Fort Smith	457	79	94	29.44	29.92	−.01	70.6	+1.0	96	29	82	46	15	60	35	61	56	64	2.86	−2.0	9	5,725	e.	31	sw.	8	14	10	7	4.7	0.0	0.0
Little Rock	357	136	144	29.56	29.93	−.02	70.6	+0.3	96	29	81	45	15	60	28	60	54	61	1.56	−3.5	10	6,465	s.	31	nw.	9	15	12	4	4.0	0.0	0.0
Brownsville	57	53	61	29.83	29.89		77.4	−1.2	90	6	84	61	13	71	21	71	70	84	2.89		6	5,729	s.	26	se.	1	9	16	6	5.1	0.0	0.0
Corpus Christi	20	11	73	29.91	29.93	+.03	75.6	−0.6	86	31	81	60	15	70	22	70	68	80	7.95	+5.2	6	9,010	se.	41	n.	19	11	10	10	5.7	0.0	0.0
Dallas	512	109	117	29.40	29.93		71.8		92	28	82	56	15	62	29				4.57		12	6,245	s.	37	s.	29	14	12	5	3.9	0.0	0.0
Fort Worth	670	106	114	29.20	29.90	−.01	71.7	−0.6	92	28	81	42	13	62	29	62	58	67	3.70	−0.6	12	6,921	s.	46	se.	29	12	13	6	4.9	0.0	0.0
Galveston	54	106	114	29.91	29.97	+.03	73.8	−1.0	84	31	78	57	15	69	16	68	66	79	4.08	+0.8	7	7,453	s.	36	nw.	6	12	13	6	4.3	0.0	0.0
Groesbeck	461	11	56	29.45	29.93		71.0		90	28	80	45	15	62	29				2.81		7	7,028	s.	33	n.	14	11	12	8	5.0	0.0	0.0
Houston	138	202	314	29.81	29.96		73.8	−1.7	90	28	82	51	15	66	25				3.94		8	8,414	se.	54	w.	6	12	14	5	4.5	0.0	0.0
Palestine	510	64	72	29.41	29.94	+.01	71.6	−1.1	92	28	81	48	15	62	25	64	61	73	6.18	+1.3	9	5,040	s.	28	nw.	10	10	15	6	5.1	0.0	0.0
Port Arthur	34	58	66	29.91	29.95		74.4		90	27	81	53	15	67	22	68	65	77	4.72		6	5,762	s.	30	sw.	1	15	11	5	4.1	0.0	0.0
San Antonio	693	119	132	29.20	29.92	+.02	74.6	−0.5	92	10	84	52	15	65	32	66	62	72	3.33	+0.4	10	5,400	se.	34	nw.	3	7	15	9	5.5	0.0	0.0
Taylor	583	55	63	29.36	29.96	+.05	72.2	−2.9	90	30	82	47	15	62	30				4.19	+0.2	9	6,189	s.	33	nw.	12	8	11	12	5.6	0.0	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, May, 1926*—Continued

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
Ohio Valley and Tennessee							65.1	+0.2										60	2.31	−1.4										4.7		
Chattanooga	762	189	213	29.14	29.94	−.05	68.8	0.0	93	27	80	49	15	58	36	57	50	57	2.72	−0.9	10	6,019	sw.	37	sw.	9	12	14	5	4.6	0.0	0.0
Knoxville	995	102	111	28.90	29.94	−.05	67.6	+0.4	94	26	79	45	16	56	38	57	50	61	3.03	−0.7	10	5,000	sw.	31	sw.	10	11	13	7	4.6	0.0	0.0
Memphis	399	76	97	29.52	29.94	−.02	71.4	+0.8	94	29	81	47	15	62	30	60	52	57	1.20	−3.1	4	5,736	sw.	35	sw.	31	17	9	5	3.9	0.0	0.0
Nashville	546	168	191	29.39	29.97	−.01	68.1	−0.1	93	25	80	45	4	57	40	58	51	59	2.15	−1.4	10	6,288	w.	34	sw.	31	13	12	6	4.3	0.0	0.0
Lexington	989	193	230	28.90	29.95	−.04	64.6	+0.3	89	25	75	34	4	54	32				2.06	−1.5	9	8,979	sw.	40	w.	10	15	10	6	3.8	0.0	0.0
Louisville	525	188	234	29.38	29.96	−.03	66.8	+0.2	92	25	78	36	4	56	33	56	49	57	1.84	−1.8	7	6,915	s.	41	s.	31	13	15	3	3.9	0.0	0.0
Evansville	431	139	175	29.50	29.96	−.01	68.5	+1.8	94	29	80	37	4	57	34	57	48	53	0.97	−2.5	5	8,235	sw.	52	w.	18	12	19	0	4.3	0.0	0.0
Indianapolis	822	194	230	29.06	29.94	−.03	64.3	+1.4	89	25	76	31	4	53	33	54	47	59	3.59	−0.4	10	8,431	s.	39	nw.	18	10	7	14	5.5	0.0	0.0
Royal Center	736	11	55	29.14	29.94		59.4		85	25	72	26	4	47	37				3.57		15	7,280	e.	38	sw.	18	9	11	11	5.5	0.0	0.0
Terre Haute	575	96	129	29.31	29.92		65.4		91	25	76	34	4	54	34	56	50	63	2.77		9	7,068	sw.	35	w.	18	9	16	6	5.2	0.0	0.0
Cincinnati	627	11	51	29.27	29.94	−.05	64.0	+0.9	88	26	76	32	4	52	33		52	67	4.65	+1.1	13	5,204	ne.	32	ne.	24	12	11	8	4.6	0.0	0.0
Columbus	822	179	222	29.08	29.95	−.05	61.7	−0.6	85	8	73	33	4	50	34	54	48	64	1.42	−2.3	10	6,830	s.	34	nw.	18	12	12	7	4.7	0.0	0.0
Dayton	899	137	173	28.98	29.92		62.8	+0.2	89	8	75	32	4	50	34	53	46	58	2.15	−1.7	8	6,502	ne.	32	sw.	31	11	15	5	4.3	0.0	0.0
Elkins	1,947	59	67	27.92	29.94	−.06	58.2	−1.0	83	2	71	33	5	46	41	51	45	65	3.04	−0.9	12	3,844	nw.	24	sw.	18	8	16	7	5.3	0.0	0.0
Parkersburg	637	77	82	29.30	29.96	−.03	63.8	0.0	88	1	76	37	4	51	39	53	46	58	1.41	−2.0	11	4,048	n.	36	nw.	30	12	8	11	5.1	0.0	0.0
Pittsburgh	842	353	410	29.04	29.93	−.06	60.9	−1.5	86	2	72	31	4	50	37	52	45	62	2.10	−1.2	10	7,290	nw.	46	w.	19	9	11	11	5.5	0.0	0.0
Lower Lake Region							55.1	−2.3										64	1.33	−1.8										4.5		
Buffalo	767	247	280	29.10	29.93	−.04	50.0	−4.6	75	29	60	25	4	40	35	46	42	75	1.11	−2.0	9	10,130	sw.	54	sw.	19	12	12	7	4.7	T.	0.0
Canton	448	10	61	29.40	29.88		51.2	−5.0	81	30	63	29	5	40	36				1.34	−1.5	10	6,802	w.	47	sw.	20	15	7	9	4.4	0.1	0.0
Oswego	335	76	91		29.91	−.06	50.0	−5.2	79	2	58	31	4	42	34			68	1.70	−1.2	8		w.	29	sw.	20	9	12	10		T.	0.0
Rochester	523	86	102	29.36	29.93	−.04	54.2	−2.9	83	2	64	30	4	44	38	46	38	56	1.63	−1.3	7	5,556	nw.	40	w.	22	15	7	9	4.7	T.	0.0
Syracuse	597	97	113	29.29	29.93	−.05	53.6	−3.7	84	2	63	29	4	44	38				1.25	−2.1	8	5,751	nw.	33	sw.	2	10	13	8	5.3	T.	0.0
Erie	714	130	166	29.16	29.93	−.04	55.0	−1.8	82	30	64	30	4	46	35	50	45	70	1.20	−2.2	10	8,083	w.	43	sw.	22	14	13	4	3.7	T.	0.0
Cleveland	762	190	201	29.12	29.94	−.04	56.9	−1.0	83	2	65	33	4	48	35	50	43	62	1.48	−1.7	8	7,701	n.	36	sw.	21	12	8	11	4.9	0.0	0.0
Sandusky	629	62	70	29.27	29.95	−.03	58.2	−1.0	84	2	66	35	3	50	32				0.83	−2.4	9	5,885	ne.	31	nw.	19	11	11	9	4.8	0.0	0.0
Toledo	628	208	243	29.27	29.95	−.02	59.4	0.0	87	7	70	33	4	49	33	51	44	60	0.70	−2.6	9	9,347	sw.	45	sw.	21	15	10	6	3.9	0.0	0.0
Fort Wayne	856	113	124	29.01	29.93		59.9	−0.3	87	8	71	30	4	48	38	52	45	62	2.56		11	6,538	ne.	31	sw.	21	15	12	7	4.6	0.0	0.0
Detroit	730	218	258	29.16	29.96	−.01	57.9	−0.1	85	8	68	33	4	47	33	48	40	57	2.09	−1.2	13	6,467	ne.	44	sw.	21	15	7	9	4.4	0.0	0.0
Upper Lake Region							52.9	−0.2										67	2.52	−0.8										4.4		
Alpena	609	13	92	29.28	29.95	−.02	49.1	−1.4	80	6	59	25	4	40	38	44	39	70	1.64	−1.7	8	7,590	se.	38	se.	21	15	10	6	4.2	0.7	0.0
Escanaba	612	54	60	29.29	29.96	−.01	48.4	−1.2	74	16	57	25	4	39	32	43	36	66	1.49	−1.9	10	7,225	s.	33	n.	21	14	9	8	3.8	0.5	0.0
Grand Haven	632	54	89	29.24	29.92	−.04	54.4	−0.1	82	7	65	25	4	44	33	48	42	66	4.66	+1.3	12	7,819	e.	38	s.	21	13	11	7	4.8	T.	0.0
Grand Rapids	707	70	87	29.18	29.95	−.02	58.0	0.0	80	8	70	27	4	46	41	50	43	61	3.44	+0.1	10	4,251	e.	22	nw.	3	13	6	12	4.9	T.	0.0
Houghton	668	62	99	29.24	29.96	−.01	50.4	+0.9	84	6	62	24	3	39	49				2.89	−0.4	11	7,858	e.	43	n.	19	14	10	7	4.6	5.3	0.0
Lansing	878	11	62	29.00	29.93		56.6	−0.3	87	8	70	25	4	43	42	50	45	67	2.39	−1.2	11	4,120	ne.	23	sw.	21	16	7	8	4.0	0.0	0.0
Ludington	637	60	66	29.24	29.94		51.5		80	8	61	24	4	42	32	46	41	69	3.90		10	7,478	s.	37	s.	21	15	11	5	3.8	T.	0.0
Marquette	734	77	111	29.16	29.96	−.01	49.3	+0.3	82	1	59	24	3	40	50	43	37	64	1.07	−2.2	13	6,899	nw.	44	sw.	1	8	15	8	5.5	3.5	0.0
Port Huron	638	70	120	29.25	29.94	−.03	52.5	−2.7	83	6	62	28	4	43	35	47	42	71	1.35	−1.9	11	7,504	ne.	44	w.	2	17	8	6	4.2	T.	0.0
Saginaw	641			29.25	29.95		55.3	−1.6	88	6	69	25	4	42	45				4.51		13		ne.				10	9	12		T.	0.0
Sault Sainte Marie	614	11	52	29.26	29.96	+.01	48.6	−0.4	80	31	61	22	3	36	40	43	37	66	1.61	−1.6	9	5,738	se.	27	nw.	19	19	6	6	3.5	0.4	0.0
Chicago	673	7	131	29.22	29.94	−.02	58.4	+0.9	85	1	68	35	4	49	43	50	45	69	2.73	−0.6	9	8,163	ne.	38	sw.	2	10	13	8	4.8	0.0	0.0
Green Bay	617	109	141	29.26	29.92	−.03	55.4	+0.5	84	30	67	31	3	44	46	49	43	66	3.83	+0.3	12	8,451	ne.	40	ne.	21	12	13	6	4.7	T.	0.0
Milwaukee	681	125	139	29.20	29.93	−.03	55.0	+0.9	87	16	65	33	3	45	43	47	41	67	4.17	+0.8	11	7,754	n.	36	sw.	21	13	8	10	4.5	T.	0.0
Duluth	1,133	5	47	28.72	29.94	−.02	48.8	+1.5	84	1	59	21	3	39	52	42	36	67	1.49	−2.0	13	10,665	ne.	43	ne.	9	14	10	7	4.4	T.	0.0
North Dakota							58.6	+4.6										55	1.92	−0.6										5.5		
Moorhead	940	50	58	28.84	29.84	−.10	60.2	+5.1	94	5	74	18	3	46	46	50	41	54	1.93	−1.0	9	7,575	n.	33	sw.	6	5	15	11	6.4	0.0	0.0
Bismarck	1,674	8	57	28.12	29.88	−.04	59.8	+5.3	97	5	72	26	3	47	48	50	40	57	2.69	+0.2	8	7,433	n.	42	sw.	24	14	11	6	4.8	0.0	0.0
Devils Lake	1,478	11	44	28.29	29.85	−.09	57.2	+5.2	97	5	71	19	3	43	40	48	39	55	1.68	−0.5	9	8,409	e.	37	e.	25	11	14	6	5.0	0.0	0.0
Ellendale	1,457	10	56	28.31	29.86		59.8		93	4	74	19	3	45	51				1.73		11	11,988	nw.	52	nw.	30	8	14	9	5.8	0.0	0.0
Grand Forks	833	12	67				59.0		96	5	72	17	3	46	45	50			2.45		8		w.	60	s.	6	11	14	6	5.4	0.0	0.0
Williston	1,878	41	48	27.90	29.86	−.07	57.0	+3.0	87	5	69	32	13	45	40	48	39	55	1.39	−0.9	8	7,091	nw.	42	nw.	31	6	16	9	5.8	0.0	0.0
Upper Mississippi Valley							64.1	+2.6										60	2.57	−1.6										4.9		
Minneapolis	918	102	208	28.87	29.84		62.5	+4.8	88	30	74	28	3	51	36				1.13	−2.8	8	9,907	se.	34	n.	2	14	8	9	5.1	0.0	0.0
St. Paul	837	236	261	28.98	29.88	−.06	61.8	+3.9	86	30	73	30	3	50	36				1.37	−2.2	8	10,532	se.	42	se.	7	13	12	6	4.6	0.0	0.0
La Crosse	714	11	48	29.14	29.90	−.04	61.8	+2.5	87	1	74	34	3	49	40				3.31	−0.4	12	3,883	se.	22	s.	1	12	11	8	5.0	0.0	0.0
Madison	974	70	78	28.89	29.93	−.03	58.2	+0.6	83	7	69	35	3	47	42	51	45	65	3.75	+0.1	14	7,153	se.	28	ne.	13	9	11	11	5.4	0.0	0.0
Wausau	1,247	4		28.61	29.93		56.4		84	7	68	28	3	44	46				3.55		11		s.				12	8	11	5.4	T.	0.0
Charles City	1,015	10	49	28.83	29.90	−.04	61.9	+4.1	90	24	75	32	3	49	39	53	46	60	3.55	−1.4	14	5,958	se.	30	sw.	20	17	9	5	3.6	0.0	0.0
Davenport	606	71	79	29.25	29.90	−.05	64.2	+2.9	93	24	77	39	15	52	37	55	48	60	2.10	−2.1	11	5,943	s.	25	ne.	26	9	16	6	5.0	0.0	0.0
Des Moines	861	84	97	28.98	29.87	−.06	65.4	+4.1	92	25	78	38	3	53	39	55	47	56	2.11	−2.4	13	6,895	sw.	32	sw.	5	9	12	10	5.4	0.0	0.0
Dubuque	700	81	96	29.14	29.88	−.07	62.5	+2.2	89	29	74	38	3	51	38	53	46	59	2.47	−1.8	14	5,268	s.	21	n.	2	10	10	11	5.7	0.0	0.0
Keokuk	614	64	78	29.24	29.91	−.03	65.8	+2.0	93	29	77	42	15	54	33	56	49	59	3.14	−1.1	10	6,109	s.	48	s.	29	9	13	9	4.9	0.0	0.0
Cairo	358	87	93	29.56	29.93	−.03	68.8	+0.4	92	25	79	43	4	58	32	58	51	60	2.26	−1.6	9	6,021	s.	50	n.	8	9	11	11	5.4	0.0	0.0
Peoria	609	11	45	29.27	29.93	−.03	64.0	+2.3	93	26	77	36	4	51	37	55	49	63	2.18	−2.1	10	5,161	s.	30	sw.	2	10	16	5	4.7	0.0	0.0
Springfield, Ill	636	10	91	29.24	29.90	−.05	66.0	+2.8	93	29	78	37	4	54	32	56	50	61	4.54	0.0	11	6,561	s.	34	sw.	18	12	10	9	4.7	0.0	0.0
Hannibal	534	74	109	29.35	29.91	−.03	66.4	+2.8	95	29	78	38	15	55	37				2.44	−2.6	7	7,110	sw.	48	w.	29	14	8	9	4.5	0.0	0.0
St. Louis	568	265	303	29.32	29.92	−.03	68.4	+1.5	94	29	78	44	4	59	27	57	50	56	1.58	−2.7	6	9,987	sw.	42	sw.	30	13	14	4	4.1	0.0	0.0
Missouri Valley							66.0	+4.6										58	2.90	−1.4										4.6		
Columbia, Mo	784	11	84	29.08	29.91	−.03	67.0	+2.7	94	29	79	36	15	55	37				2.87	−2.0	12	5,812	s.	31	nw.	31	13	9	9	4.5	0.0	0.0
Kansas City	963	161	181	28.87	29.89	−.03	68.6	+3.8	91	28	79	44	14	58	30	58	51	59	1.53	−3.6	14	8,427	s.	34	nw.	31	13	12	6	4.5	0.0	0.0
St. Joseph	967	11	49	28.86	29.88		68.3		94	26	80	41	14	57	34	57	50	57	0.99		10	7,098	sw.	30	nw.	31	16	12	3	3.5	0.0	0.0
Springfield, Mo	1,324	98	104	28.57	29.95	+.02	66.2	+1.7	90	29	76	42	14	56	27	57	50	60	4.50	−1.0	10	7,699	s.	33	s.	30	19	9	3	2.8	0.0	0.0
Iola	984	11	50	28.86	29.90	−.02	68.2	+3.0	94	29	80	39	15	56	37				2.76	−2.5	14	5,131	s.	24	nw.	8	12	16	3	4.2	0.0	0.0
Topeka	987	92	107				67.6	+3.3	92	26	79	42	14	56	33				3.01	−1.9	13	7,394	sw.	31	se.	8	12	14	5	4.5	0.0	0.0
Drexel	1,299	10	54	28.48	29.86		60.8		85	1	71	34	14	51	34				1.81		9	5,910	s.	56	w.	16	5	8	7	5.6	0.0	0.0
Lincoln	1,189	11	84	28.61	29.85	−.06	66.2	+4.5	94	24	77	38	14	55	35	57	50	59	2.95	−1.3	12	8,791	s.	36	nw.	16	8	14	9	5.4	0.0	0.0
Omaha	1,105	115	122	28.70	29.86	−.06	67.0	+4.6	95	24	77	40	14	57	33	56	48	56	1.87	−2.6	14	6,356	s.	32	ne.	18	12	13	6	4.5	0.0	0.0
Valentine	2,598	47	54	27.18	29.86	−.04	62.4	+6.2	98	23	75	29	14	50	43	52	44	59	2.37	−1.0	12	8,132	nw.	35	n.	1	8	15	8	5.2	0.0	0.0
Sioux City	1,135	94	164	28.67	29.86	−.06	65.6	+5.2	93	25	76	35	3	55	32	55	47	57	4.83	+0.5	13	10,281	s.	54	s.	28	7	17	7	5.3	0.0	0.0
Huron	1,306	59	74	28.48	29.86	−.06	64.2	+7.8	97	23	77	29	3	51	48	53	45	56	2.77	−0.2	12	8,245	s.	38	ne.	1	12	15	4	4.2	0.0	0.0
Pierre	1,572	70	75		29.84	−.07	64.0	+6.0	101	23	77	37	14	51	49			55	3.32	+1.2	13	7,354	nw.	43	w.	28	6	16	9		0.0	0.0
Yankton	1,233	49	57	28.54	29.84	−.08	65.4	+6.0	95	24	77	35	3	54	28				2.02	−1.9	15	7,204	nw.	36	nw.	1	6	18	7	5.9	0.0	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, May, 1926*—Continued

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature: Departure from normal	Temperature: Maximum	Temperature: Date	Temperature: Mean maximum	Temperature: Minimum	Temperature: Date	Temperature: Mean minimum	Temperature: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
Northern Slope							56.0	+3.2										58	2.39	0.0										5.7		
Billings	3,140	5					57.8		84	23	71	35	8	44	45				1.64		12		nw.				13	5	13		0.0	0.0
Havre	2,505	11	44	27.27	29.88	−.02	58.0	+4.6	83	14	71	34	8	45	43	47	38	54	1.14	−1.0	8	5,798	sw.	35	sw.	23	8	22	1	4.7	0.0	0.0
Helena	4,110	87	112	25.77	29.93	.00	53.7	+2.1	75	22	64	34	9	43	33	44	36	57	2.48	+0.5	11	6,875	sw.	40	sw.	20	7	8	16	6.8	T.	0.0
Kalispell	2,973	48	56	26.90	29.95	+.07	51.9	+0.5	71	2	63	31	8	41	32	43	35	59	1.23	−0.8	11	4,712	se.	32	sw.	19	6	16	9	5.8	0.0	0.0
Miles City	2,371	48	55	27.40	29.92	+.02	60.4	+3.7	90	24	72	34	13	49	44	49	40	54	1.49	−0.5	8	4,966	n.	30	n.	24	10	12	9	5.1	0.0	0.0
Rapid City	3,259	50	58	26.53	29.90	.00	59.2	+5.2	90	24	70	34	14	48	45	49	40	54	8.07	+5.2	16	6,238	nw.	28	n.	16	13	13	12	6.4	0.0	0.0
Cheyenne	6,088	84	101	23.97	29.87	+.02	53.0	+2.7	82	23	64	25	14	42	41	44	36	61	1.75	−0.7	11	8,573	w.	48	sw.	20	8	9	14	6.4	T.	0.0
Lander	5,372	60	68	24.00	29.89	+.01	54.6	+3.4	80	23	66	34	10	43	39	45	36	55	2.25	−0.6	11	4,582	sw.	36	sw.	24	7	17	7	5.5	0.0	0.0
Sheridan	3,790	10	47	26.05	29.92		55.6		87	24	68	31	14	43	46	48	40	63	3.05		16	3,599	nw.	38	nw.	24	7	12	12	5.8	0.0	0.0
Yellowstone Park	6,241	11	48	23.86	29.92	+.01	48.4	+1.0	72	22	60	28	13	37	36	40	32	60	2.19	+0.3	15	6,012	s.	36	s.	4	6	18	7	5.7	0.7	0.0
North Platte	2,821	11	51	27.00	29.88	.00	64.6	+5.9	98	23	77	32	14	52	42	53	45	50	0.91	−2.2	12	6,337	s.	28	s.	5	15	7	9	4.8	0.0	0.0
Middle Slope							64.7	+2.2										61	1.99	−1.8										5.1		
Denver	5,292	106	113	24.69	29.88	+.04	58.6	+2.4	89	23	69	37	11	48	32	47	38	56	1.41	−1.1	11	5,431	s.	34	nw.	30	7	14	10	5.8	T.	0.0
Pueblo	4,685	80	86	25.24	29.86	+.03	60.4	+1.2	90	23	73	37	9	48	40	48	40	55	1.64	0.0	10	4,677	n.	38	sw.	24	7	16	8	5.5	0.0	0.0
Concordia	1,392	50	58	28.41	29.86	−.05	67.2	+4.0	92	26	77	40	14	57	31	56	49	59	1.93	−2.8	10	6,908	s.	29	w.	17	11	12	8	5.1	0.0	0.0
Dodge City	2,509	11	51	27.34	29.91	+.04	64.3	+0.8	91	24	76	39	13	53	37	55	50	67	2.42	−0.9	11	7,468	se.	37	se.	5	15	11	5	3.9	0.0	0.0
Wichita	1,358	139	158	28.47	29.88	−.02	67.4	+2.3	91	28	78	42	14	57	32	58	52	63	2.47	−2.5	9	9,870	s.	46	w.	18	9	19	3	5.0	0.0	0.0
Broken Arrow	765	11	56	29.10	29.92		68.2		92	29	79	44	15	57	30				4.09		6	9,808	s.	52	nw.	17	8	15	8	5.7	0.0	0.0
Oklahoma City	1,214	10	47	28.64	29.90	+.01	70.2	+2.5	94	29	81	45	15	59	31	60	55	66	2.09	−3.7	5	7,973	s.	26	sw.	30	10	15	6	5.0	0.0	0.0
Southern Slope							69.2	−1.4										60	2.43	−0.3										4.7		
Abilene	1,738	10	52	28.11	29.88	+.01	72.0	0.0	97	31	84	44	15	60	35	61	55	62	2.65	−1.1	7	7,649	s.	31	nw.	2	11	16	4	4.9	0.0	0.0
Amarillo	3,676	10	49	26.22	29.89	+.05	64.4	+0.3	87	20	76	41	14	53	36	54	47	62	3.98	+0.3	15	7,672	s.	38	sw.	28	17	7	7	4.4	0.0	0.0
Del Rio	944	64	71	28.91	29.88	+.03	74.8	−2.2	91	10	84	49	13	66	30				1.06	−1.3	6	7,088	se.	30	ne.	3	10	11	10	5.5	0.0	0.0
Roswell	3,566	75	85	26.30	29.85	+.03	65.6	−3.8	93	21	79	40	13	52	37	53	44	56	2.03	+0.9	13	5,958	n.	38	s.	25	15	12	4	3.9	0.0	0.0
Southern Plateau							66.0	+0.6										44	0.80	+0.5										2.8		
El Paso	3,778	152	175	26.13	29.84	+.06	70.3	−1.2	95	22	83	49	12	58	36	52	37	37	0.70	+0.4	4	5,548	nw.	49	n.	29	21	8	2	2.5	0.0	0.0
Santa Fe	7,013	38	53	23.24	29.85	+.04	54.0	−1.7	79	20	65	34	11	43	32	43	35	57	3.14	+2.0	16	4,427	e.	29	sw.	24	6	14	11	6.1	0.2	0.0
Flagstaff	6,907	10	59	23.36	29.88	+.10	50.0	−0.7	78	31	65	27	10	35	41	39		55	0.77		6	5,830	nw.	32	s.	24	12	17	2		0.0	0.0
Phoenix	1,108	10	82	28.69	29.83	+.05	75.8	+0.8	102	31	91	51	9	60	37	56	38	33	0.18	+0.2	2	3,716	w.	23	w.	23	22	8	1	2.2	0.0	0.0
Yuma	141	9	54	29.67	29.82	+.03	77.6	+1.4	105	29	94	54	8	61	43	59	43	37	0.00	0.0	0	4,259	w.	30	w.	5	29	2	0	0.6	0.0	0.0
Independence	3,957	5	25	25.80	29.86	+.02	68.0	+5.0	95	31	84	37	8	52	40	48			T.	−0.2	0		nw.				19	7	5	2.6	0.0	0.0
Middle Plateau							58.8	+2.9										44	0.80	−0.3										4.1		
Reno	4,532	74	81	25.46	29.93	+.02	57.0	+4.0	87	31	73	30	9	42	40	44	32	45	0.13	−0.6	1	5,973	w.	44	w.	4	18	10	3	3.2	T.	0.0
Tonopah	6,090	12	20				59.0		84	31	70	29	8	48	28	43	26	32	T.		0		nw.									
Winnemucca	4,344	18	56	25.60	29.96	+.05	56.8	+2.9	88	31	74	26	9	40	43	44	33	50	0.53	−0.5	3	4,694	sw.	34	nw.	4	17	14	0	3.5	0.0	0.0
Modena	5,479	10	43	24.58	29.86	+.04	56.2	+2.7	86	31	71	27	10	41	42	43	29	44	0.31	−0.6	4	7,953	sw.	47	sw.	23	13	13	5	4.1	0.0	0.0
Salt Lake City	4,360	[illegible]	203	25.58	29.90	+.04	60.7	+3.3	87	22	70	37	9	51	32	47	35	44	2.10	+0.2	9	5,899	nw.	47	w.	19	11	12	8	4.9	0.0	0.0
Grand Junction	4,602	60	68	25.32	29.86	+.03	62.9	+1.8	88	22	75	38	10	50	34	49	39	47	0.93	0.0	6	4,695	se.	37	nw.	30	7	19	5	5.0	0.0	0.0
Northern Plateau							57.6	+1.4										54	0.94	−0.8										5.7		
Baker	3,471	48	53		30.04	+.08	51.8	+0.1	78	31	65	28	6	39	44			70	0.93	−0.8	10	4,406	se.	20	nw.	22	11	7	13		T.	0.0
Boise	2,739	78	86	27.14	29.99	+.05	58.7	+1.6	85	19	72	33	9	45	40	47	37	53	1.09	−0.2	5	3,911	nw.	28	w.	6	10	13	8	4.7	0.0	0.0
Lewiston	757	40	48	29.21	30.01	+.05	60.4	+0.9	87	13	73	38	9	48	44				1.46	−0.2	12	2,839	e.	28	nw.	29	5	10	16	6.7	0.0	0.0
Pocatello	4,477	60	68	25.44	29.91	+.02	57.3	+3.5	84	22	70	32	10	45	38	44	32	46	0.54	−1.7	7	6,637	sw.	42	sw.	20	7	14	10	5.7	T.	0.0
Spokane	1,929	101	110	29.95	30.00	+.04	56.6	+1.1	83	13	68	35	9	45	35	46	35	52	0.57	−0.8	8	5,615	s.	28	sw.	20	6	14	11	6.0	0.0	0.0
Walla Walla	991	57	65	28.93	30.00	+.04	60.7	+1.1	87	13	72	38	6	50	37	50	39	50	1.05	−0.8	14	3,569	s.	23	w.	19	9	12	10	5.3	0.0	0.0
North Pacific Coast Region							56.5	+2.8										73	3.38	+1.1										6.6		
North Head	211	11	56	29.82	30.04	+.01	53.8	+2.9	76	10	58	44	7	50	26	51	48	83	6.46	+4.1	22	11,576	s.	68	s.	6	2	7	22	8.4	0.0	0.0
Port Angeles	29	8	53		30.04		52.1		74	12	60	35	6	44	29				1.76	+0.5	15	4,510	sw.	28	w.	4	3	9	19		0.0	0.0
Seattle	125	215	250	29.90	30.03	+.02	56.4	+1.9	88	12	64	42	6	49	31	50	44	70	1.83	0.0	17	7,596	s.	38	sw.	7	6	11	14	6.6	0.0	0.0
Tacoma	194	172	201	29.84	30.04	+.02	56.8	+2.7	86	12	65	34	6	49	31				2.72	+0.5	18	6,038	s.	37	sw.	7	4	16	11	6.3	0.0	0.0
Tatoosh Island	86	9	53	29.91	30.01	.00	53.1	+3.5	81	12	57	44	1	49	28	50	47	82	6.34	+2.2	25	10,082	s.	49	e.	6	3	7	21	7.5	0.0	0.0
Yakima	1,071	5					57.0		84	11	73	28	6	40	42				0.14		2		nw.				9	12	10	5.7		
Medford	1,425	4					60.2		91	31	76	32	8	45	49	51	44	65	0.73		4		nw.				15	7	9		0.0	0.0
Portland, Oreg.	153	68	106	29.88	30.04	+.01	59.2	+2.3	87	12	68	42	25	50	32	54	49	74	2.83	+0.6	18	4,189	nw.	23	s.	6	6	6	19	7.3	0.0	0.0
Roseburg	510	9	57	29.52	30.07	+.04	59.7	+3.7	89	11	73	37	24	47	43	51	44	66	1.74	−0.3	11	2,529	nw.	24	w.	3	12	13	6	4.5	0.0	0.0
Middle Pacific Coast Region							61.2	+2.7										66	0.62	−0.6										3.3		
Eureka	62	73	89	30.05	30.12	+.07	55.4	+3.4	71	19	62	42	8	49	18	52	49	80	1.13	−1.4	8	5,330	n.	29	s.	5	6	20	5	5.2	0.0	0.0
Point Reyes	490	7	18	29.45	29.97		53.8	+2.2	60	1	58	47	31	50	12				0.16		2	21,596	nw.	66	nw.	28	15	11	5	3.7	0.0	0.0
Red Bluff	332	50	56	29.60	29.95	.00	68.6	+2.3	100	31	82	39	8	55	38	56	47	52	1.25	−0.1	6	4,182	se.	22	se.	4	25	5	1	2.5	0.0	0.0
Sacramento	69	106	117	29.88	29.95	+.01	66.4	+3.1	98	31	80	43	7	53	37	56	48	60	0.36	−0.6	2	5,798	s.	27	s.	22	25	5	1	1.7	0.0	0.0
San Francisco	155	208	243	29.84	30.02	+.03	61.0	+4.2	82	11	68	51	8	54	28	54	50	74	0.15	−0.7	3	7,500	w.	31	nw.	23	13	14	4	4.1	0.0	0.0
San Jose	141	12	110	29.87	30.02		61.9	+1.2	93	31	76	40	9	48	41				0.21	−0.3	3	4,912	nw.	23	nw.	29	21	8	2	2.6	0.0	0.0
South Pacific Coast Region							65.4	+3.3										64	0.07	−0.5										2.9		
Fresno	327	89	98	29.60	29.95	+.03	70.5	+3.4	101	31	85	46	8	56	34	55	43	45	0.03	−0.6	2	7,429	nw.	31	nw.	22	25	5	1	1.7	0.0	0.0
Los Angeles	338	159	191	29.60	29.96	+.01	65.4	+3.2	89	11	74	50	9	57	28	58	53	71	0.18	−0.3	2	3,956	sw.	19	sw.	6	14	12	5	3.8	0.0	0.0
San Diego	87	62	70	29.87	29.96	+.01	63.8	+3.0	80	12	69	52	10	59	21	58	55	76	0.01	−0.4	1	5,089	sw.	24	nw.	10	15	6	10	4.7	0.0	0.0
San Luis Obispo	201	32	40	29.80	30.02	+.02	61.8	+3.6	89	28	75	41	24	49	41	52	46	65	0.06	−0.8	2	3,772	nw.	21	w.	23	25	6	0	1.4	0.0	0.0
West Indies																																
San Juan, P. R.	82	9	54	29.87	29.96		79.8	+1.2	91	30	86	70	6	74	17				3.13	−1.6	19	7,297	e.	29	n.	6	6	19	6	5.2	0.0	0.0
Panama Canal																																
Balboa Heights	118	7	97	29.72	29.84	+.01	82.3	+1.6	95	13	89	73	7	76	19	76	75	85	4.16	−3.8	11	5,872	nw.	27	nw.	1	0	14	17	7.6	0.0	0.0
Colon	38	7	97	29.82	29.85	+.01	83.1	+2.4	94	7	89	74	29	77	20	78	77	83	13.73	+1.4	17	5,477	n.	19	n.	1	2	10	19	7.8	0.0	0.0
Alaska																																
Juneau	80	11	54				49.0		67	31	57	36	22	41	27	46	42	77	3.72		18	5,172	s.	32	se.	8	3	9	19	7.9	0.0	0.0
Hawaiian Islands																																
Honolulu	38	86	100				76.0		82	10	81	67	10	71	15	67	63	65	0.08	−1.7	3	7,950	e.	32	e.	22	11	18	2	4.7	0.0	0.0

TABLE 2.—*Data furnished by the Canadian Meteorological Service, May, 1926*

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max.+mean min.÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*In.*	*In.*	*In.*	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*	*In.*	*In.*	*In.*
St. Johns, N. F.	125	29.64	29.78	−.20	40.9	−2.0	47.4	34.3	62	32	3.76	+0.10	0.0
Sydney, C. B. I.	48	29.79	29.84	−.13	43.8	−1.4	51.9	35.7	68	30	6.00	+2.23	0.0
Halifax, N. S.	88	29.70	29.80	−.18	46.9	−1.5	55.2	38.7	71	31	6.78	+2.52	T.
Yarmouth, N. S.	65	29.70	29.77	−.21	46.6	−1.0	54.0	39.1	65	32	1.97	−1.83	0.0
Charlottetown, P. E. I.	38	29.73	29.77	−.19	44.9	−2.0	52.5	37.4	68	28	2.94	+0.03	1.5
Chatham, N. B.	28	29.70	29.73	−.22	45.0	−3.5	54.9	35.2	73	27	3.48	+0.27	0.0
Father Point, Que.	20	29.80	29.82	−.11	41.4	−2.6	48.0	34.8	70	30	3.84	+1.26	0.0
Quebec, Que.	296	29.53	29.84	−.10	49.0	−0.9	57.4	40.5	76	31	2.52	−0.56	0.0
Montreal, Que.	187	29.64	29.85	−.09	52.6	−2.1	61.7	43.5	80	32	1.35	−1.60	T.
Stonecliffe, Ont.	489												
Ottawa, Ont.	236	29.62	29.88	−.06	52.3	−2.6	63.9	40.8	82	28	1.53	−1.06	0.0
Kingston, Ont.	285	29.59	29.90	−.06	51.4	−1.5	60.5	42.3	71	30	0.93	−1.75	0.0
Toronto, Ont.	379	29.51	29.92	−.06	52.7	−0.5	62.8	42.6	80	29	1.29	−1.75	T.
Cochrane, Ont.	930				46.3		55.3	37.4	86	12	0.04		T.
White River, Ont.	1,244	28.62	29.94	−.01	44.7	−1.0	60.8	28.7	85	12	0.31	−1.64	2.8
Port Stanley, Ont.	592												
Southampton, Ont.	656	29.22			46.7	−4.0	57.4	35.9	76	24	1.53	−0.91	0.6
Parry Sound, Ont.	688	29.23	29.93	−.02	48.5	−2.6	59.7	37.4	76	21	2.74	−0.19	0.2
Port Arthur, Ont.	644	29.26	29.97	+.01	47.0	+1.1	57.0	37.0	84	18	0.69	−1.46	0.0
Winnipeg, Man.	760												
Minnedosa, Man.	1,690												
Le Pas, Man.	860				48.6		61.0	36.2	80	14	1.15		0.0
Qu'Appelle, Sask.	2,115	27.60	29.83	−.11	52.8	+3.0	64.6	41.0	80	20	3.04	+1.39	0.0
Medicine Hat, Alb.	2,144	27.56	29.80	−.09	58.6	+4.5	71.1	46.2	83	33	1.65	+0.34	0.0
Moose Jaw, Sask.	1,759				55.8		68.4	43.3	84	27	2.37		0.0
Swift Current, Sask.	2,392	27.38	29.88	−.04	55.8	+5.1	69.4	42.2	84	24	2.65	+0.80	0.0
Calgary, Alb.	3,428												
Banff, Alb.	4,521	25.32	29.86	−.02	46.9	−0.1	59.4	34.4	77	24	1.24	−0.80	1.2
Edmonton, Alb.	2,150	27.55	29.81	−.07	51.9	+1.1	65.9	38.0	76	30	3.61	+2.06	0.0
Prince Albert, Sask.	1,450	28.31	29.88	−.07	52.2	+4.6	63.3	41.1	86	22	3.01	+1.75	0.0
Battleford, Sask.	1,592	28.13	29.85	−.07	53.8	+2.8	65.6	42.0	85	24	3.02	+1.40	0.0
Kamloops, B. C.	1,262												
Victoria, B. C.	230	29.76	30.02	+.02	54.4	+1.9	60.8	48.0	82	42	1.85	+0.37	0.0
Barkerville, B. C.	4,180												
Triangle Island, B. C.	690												
Prince Rupert, B. C.	170												
Hamilton, Ber.	151	29.86	30.02	−.04	69.0	−0.4	75.0	63.1	81	57	6.56	+1.90	0.0

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St. Johns, N. F.	125	29.51	29.65	−.24	33.0	−1.5	39.5	26.4	57	14	4.31	+0.15	10.5
Calgary, Alb.	3,428	26.44	30.04	+.14	43.0	+3.4	57.5	28.5	85	6	1.03	+0.39	7.6
Kamloops, B. C.	1,262	28.69	29.98	+.05	53.4	+4.5	67.7	39.2	86	20	0.36	−0.03	T.
Barkerville, B. C.	4,180	25.63	29.95	+.09	39.5	+6.4	52.7	26.4	82	0	2.40	+0.58	T.

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Chart II. Tracks of Centers of Cyclones, May, 1926. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by Wilfred P. Day)


Shaded portions show excess (+).
Unshaded portions show deficiency (−).
Lines show amount of excess or deficiency.

Chart IV. Total Precipitation, Inches, May, 1926. (Inset) Departure of Precipitation from Normal

Chart V. Percentage of Clear Sky between Sunrise and Sunset, May, 1926

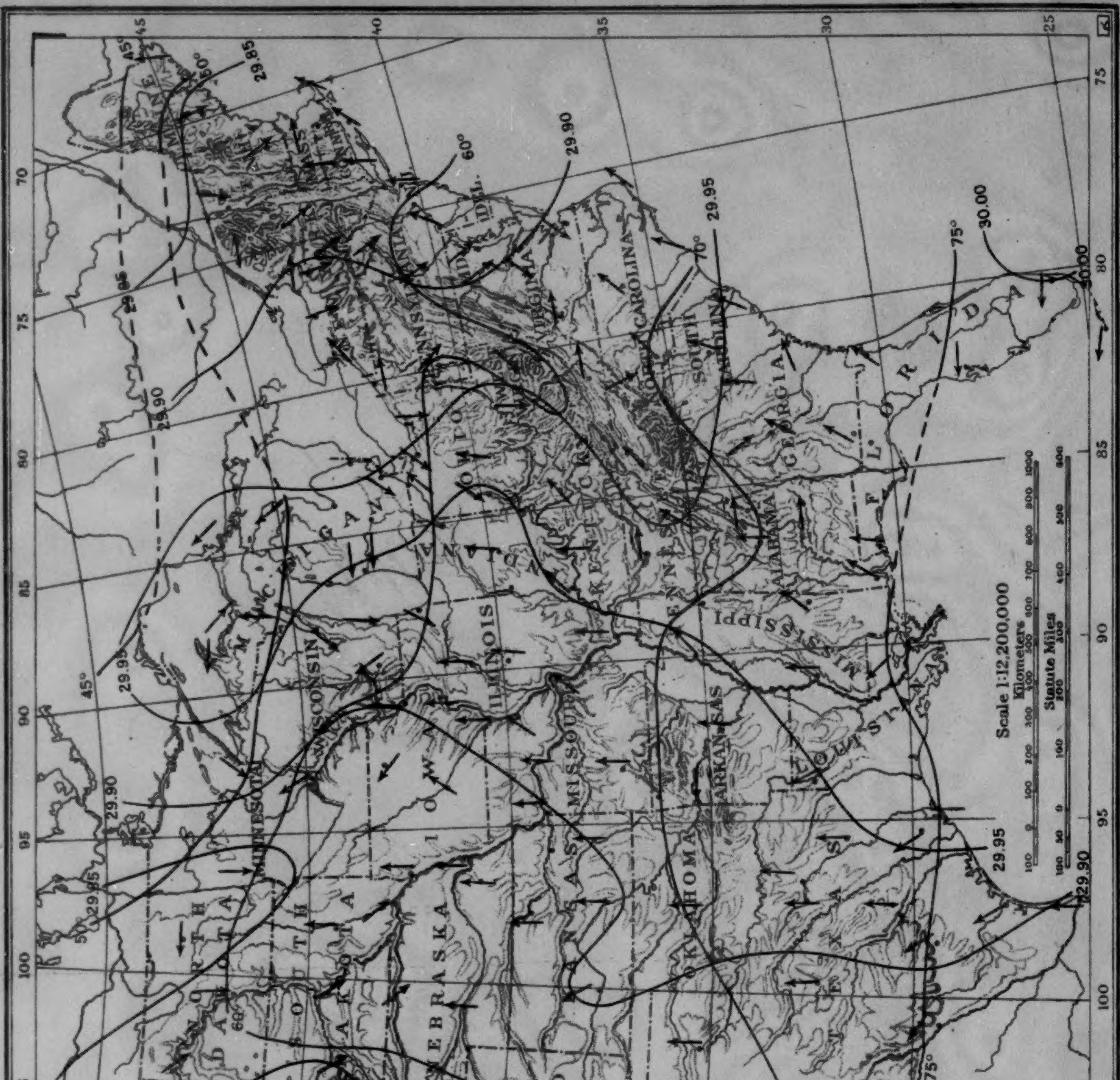


Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, May, 1926

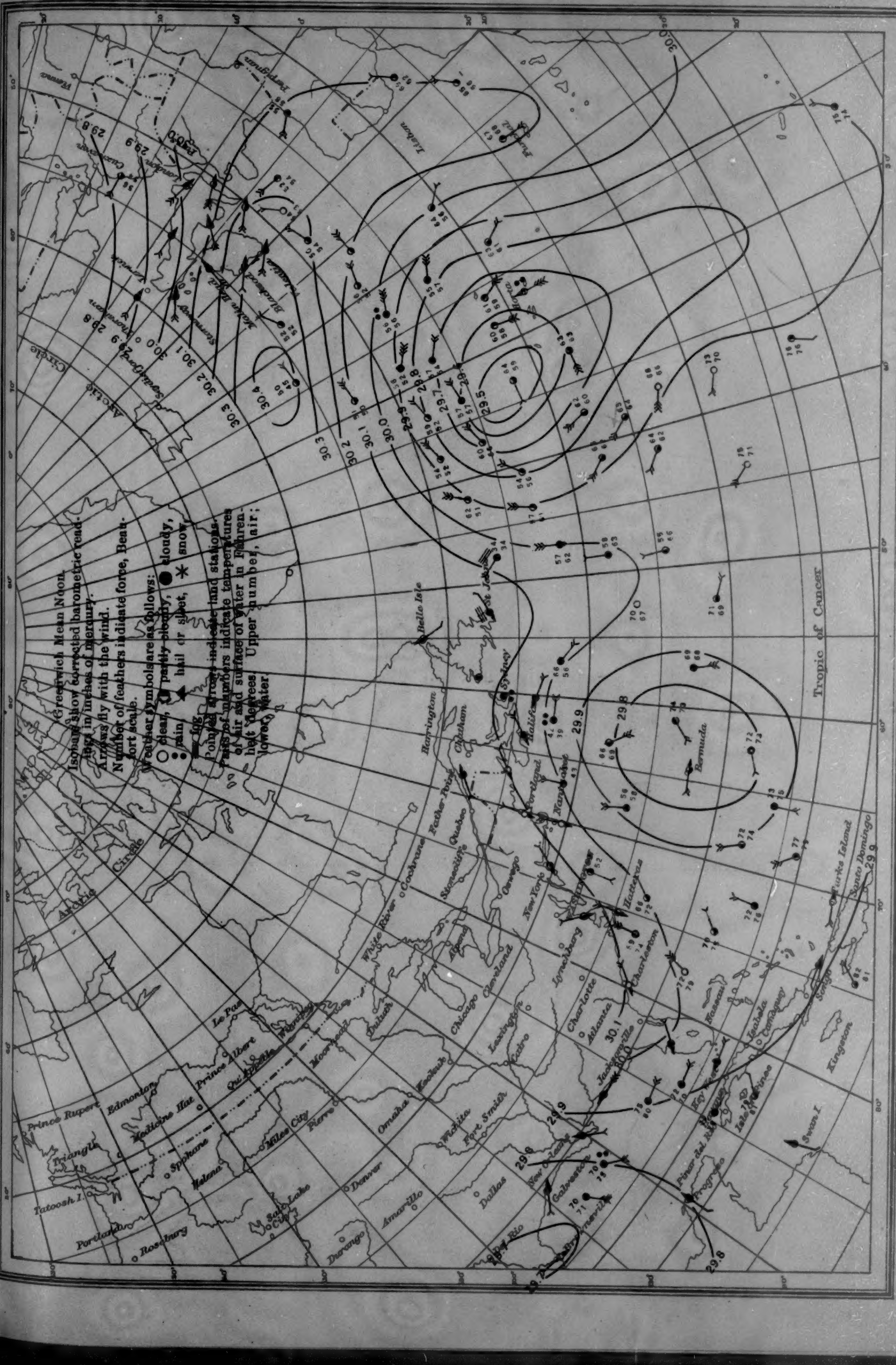
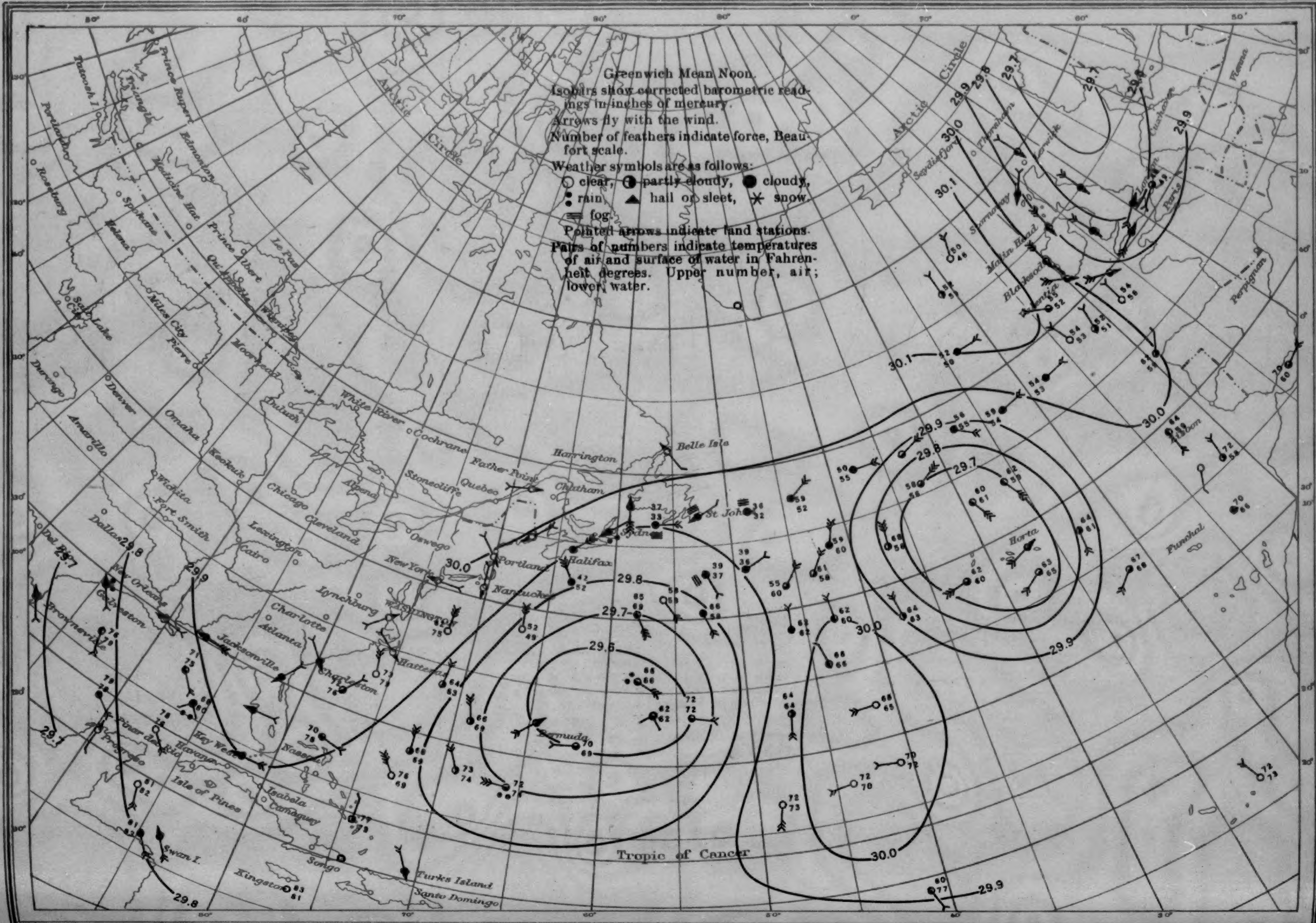

(Plotted by F. A. Young)
Greenwich Mean Noon.
Isobars show corrected barometric readings in inches of mercury.
Arrows fly with the wind.
Number of feathers indicate force, Beaufort scale.
Weather symbols are as follows:
clear, partly cloudy, cloudy, rain, hail or sleet, snow, fog.
Pointed arrows indicate land stations.
Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water.
Arctic Circle
Tropic of Cancer
Bermuda

Chart IX. Weather Map of North Atlantic Ocean, May 7, 1926
(Plotted by F. A. Young)



(Plotted by F. A. Young)

(Plotted by F. A. Young)

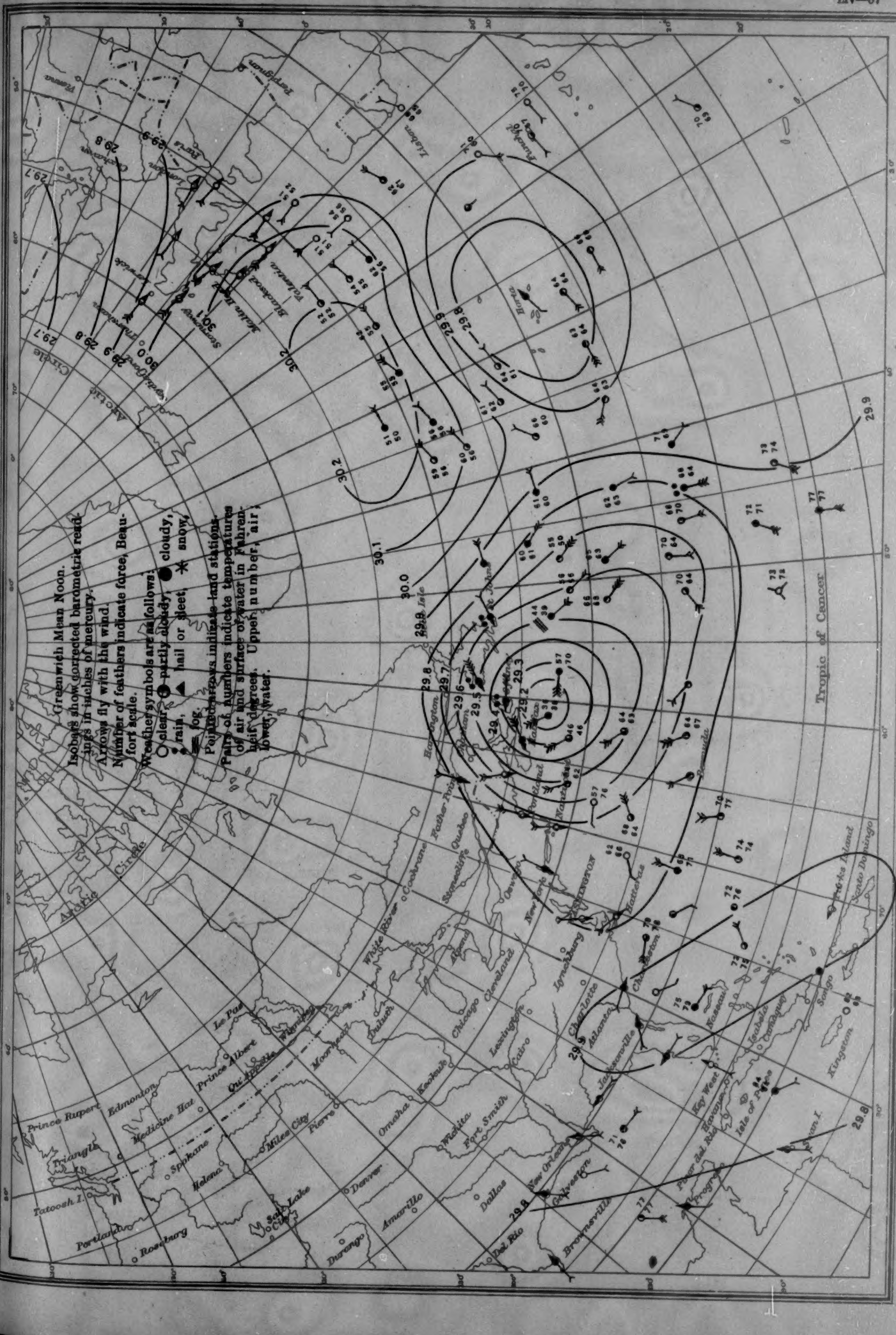


Chart XI. Weather Map of North Atlantic Ocean, May 9, 1926

(Plotted by F. A. Young)